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ORIGINAL ARTICLES.

I.—Note on a nearly complete Skeleton of *Æpyornis* from Madagascar.

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(PLATE IX.)

THE growth of our knowledge of the gigantic extinct birds of Madagascar has been a very slow one. The first notice of their occurrence was published in 1851 by I. Geoffroy St. Hilaire; but it is only within the last two or three years that any part of their skeleton, except the bones of the leg and some very imperfect vertebræ, has been described. Recently, however, the collections that have reached the Museum of Natural History at Paris, and those obtained by Dr. Forsyth Major for the British Museum, have filled most of the gaps, and all the important parts of the skeleton are now known.

The present note is a preliminary account of a nearly complete skeleton, that may for the present be referred to *Æpyornis Hildebrandti*, a species described in 1893 by Burckhardt [1] on the evidence of the bones of the leg and an imperfect pelvis. Unfortunately, this specimen is not composed of the bones belonging to one individual, but has been reconstructed from the immense series of remains collected in the neighbourhood of Sirabé by Dr. C. I. Forsyth Major and his companion, M. Robert, during their recent visit to Madagascar. This collection includes many hundreds of bones, nearly all referable to this species, so that, in spite of the considerable degree of individual variation in size to which these birds are subject, it has been possible to construct a skeleton which must, at least, very nearly resemble one belonging to a single individual.

Many of the more important parts of this specimen, including the skull, sternum, shoulder-girdle, and humerus, have already been described and figured in the *Ibis* for July, 1896, and only their more striking peculiarities need here be noticed, while in the case of the vertebral column and pelvis a somewhat more detailed, but necessarily brief account will be given.

[1] "Ueber *Æpyornis*": Palaeontologische Abhandlungen, neue Folge, Bd. ii, Heft 2. (Jena, 1893.)

Of the skull no complete specimen is known, but a nearly perfect cranial portion, the anterior part of the beak, and a mandible were described and figured in the paper above referred to (pl. viii). The *foramen magnum* is large and oval, the occipital condyle pedunculate, and there is a precondylar fossa. The paroccipital processes are large, but only extend downwards a little below the condyle. The lambdoidal crest is weak, and the occipital surface passes into the roof of the skull by a gentle curve. The surface of the frontals is marked by several rows of deep pits which indicate the presence of a crest of large feathers. The tympanic cavity is shallow, but the temporal fossa is very deep and narrow; there is a large zygomatic process. The basi-temporal platform is very prominent: anteriorly it bears a pair of large basi-pterygoid processes, and laterally it is grooved by the eustachian canals, which remain open as in *Dinornis*. There is only a single facet for articulation with the quadrate. This bone is chiefly remarkable for the great expansion of its orbital process, which forms a broad plate with a rough inner surface in which some pneumatic foramina occur. The single convex facet for articulation with the cranium is somewhat triangular in outline, and the articular surface for the mandible is completely divided into two facets, the inner convex in all directions, the outer concave from side to side. On the inner side of the bone there is a broad surface for union with the hinder extremity of the pterygoid (γ_1), on the outer a deep cup for the posterior end of the jugal arch.

The rami of the mandible are very broad (from side to side) and massive. The articular surface for the quadrate is deep, and there are well-developed posterior and internal angular processes.

The vertebral column as reconstructed consists of twenty true cervicals and eight vertebræ bearing free ribs, of which probably the three anterior are cervico-dorsals. The fused pelvic vertebræ are about twenty in number. It is, of course, possible that a mistake may have been made in the number of vertebræ, but as far as it is possible to judge by the gradual increase and decrease in size of the various processes from one region to another, the column as now mounted must be very nearly correct.

In the atlas vertebra, of which a very perfect specimen is preserved (Fig. 1, A), the cup for the occipital condyle is deep and circular in outline: it is nearly complete, the cleft in its dorsal margin being comparatively narrow and only extending downwards about one-third of the diameter. The posterior articular surface is shaped somewhat like the letter B, the straight border being the dorsal margin, while the two lobes are two nearly completely separated, slightly concave, articular surfaces for the axis. The inferior angles of these lobes are produced into short processes forming lateral hypapophyses: there is no trace of a median hypapophysis. The neural arch is very large, and its two halves are completely fused above. The pedicels are narrow, but superiorly the arch is greatly expanded, forming a backwardly projecting wing which forks posteriorly into an upper and lower lobe. The upper

bears on its inner face the nearly circular posterior zygapophysis, which looks inward and backward; above this there is a strongly developed hyperapophysis. The lower lobe consists of a downwardly and backwardly directed process, the base of which is perforated by a large foramen; it seems to be homologous with the process in the atlas of *Rhea*, which is regarded by Mivart as the diapophysis. At the same time the perforation of the base gives it much the appearance of a fused cervical rib, of which the capitulum has shifted up into the arch. The posterior border of the middle of the neural arch is deeply concave: the anterior has been broken away.

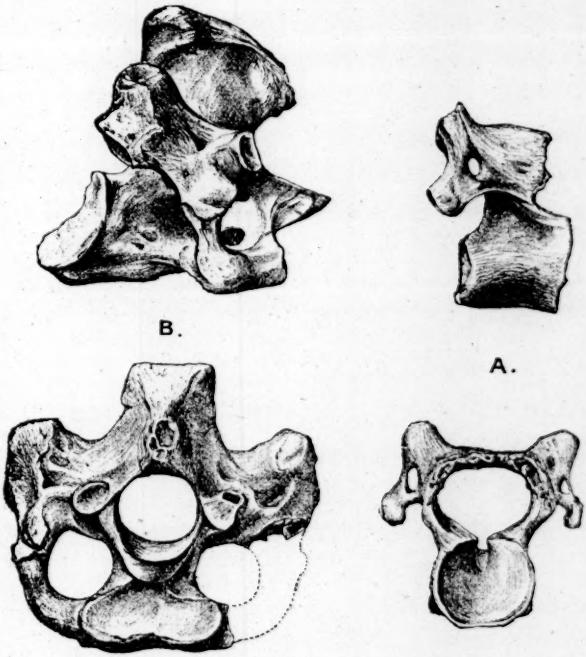


Fig. 1.—A. Atlas of *Æpyornis* from front and side.
B. Axis ,, ,, ,,
All the figures natural size. The axis belonged to a rather larger individual than the atlas.

The atlas thus differs widely from that of *Struthio* in the completeness of the cup for the occipital condyle, the absence of the costal element enclosing a vertebrarterial canal, the presence of a large diapophysis, and the absence of a median hypapophysis. In the first three of these characters it differs also from *Dinornis*. Of the other Ratitæ, *Rhea* most resembles this specimen, in the structure of the atlas, the form of the arch, and in the anterior articulation being closely similar; in *Dromæus* also there is no

costal element enclosing a canal. On the other hand, there is a median hypapophysis, and hyperapophyses are wanting. The atlas of *Casuarius* also shows some points of similarity.

In the *axis* the preaxial surface of the centrum is concave from above downward, about three times as wide as high, and imperfectly divided into two facets, corresponding to the posterior articular surface of the atlas. The postaxial surface is of the usual saddle shape, and much higher than wide; it presents somewhat the appearance of two crescents joined back to back, and both its dorsal and ventral borders are deeply concave. The ventral surface of the centrum as far back as the hinder border of the parapophyses is very broad: behind this it becomes laterally compressed, and bears a low hypapophysial keel which extends nearly to its hinder edge. On the broad anterior portion a little behind its anterior margin there is a well-marked transverse ridge extending up on to the fused rib.

The odontoid process is short and broad: on its ventral side, separating its proper articular surface from the upward continuation on to its base of the anterior surface of the centrum, there is a shallow pit for the insertion of a ligament.

The neural arch is a very massive structure, of which the pedicels are very short and broad. The upper border of the neural spine slopes upward and backward, in which direction also it thickens, so that posteriorly it is broad and shows traces of the bifid condition met with in the succeeding vertebræ; its posterior surface bears a deep pit for ligaments. The anterior zygapophyses are merely small circular facets on the anterior border of the arch, from which they scarcely project at all. The posterior ones are very large and look downward and slightly backward; they are surmounted by very large tuberous hyperapophyses. The fused cervical rib enclosing the vertebrarterial canal is greatly expanded at its upper end, and there is a broad interzygapophysial bar and a small interzygapophysial foramen. The inner wall of the vertebrarterial canal bears three large pneumatic foramina, the upper one perforating the arch, the lower the centrum.

The axis above described differs from that of *Struthio* in possessing a much more prominent neural spine and hyperapophyses, a shorter centrum, a much smaller hypapophysis, much larger vertebrarterial canals (in *Struthio* these are very small), and less developed anterior zygapophyses. Moreover, in *Struthio* the posterior articular surface of the centrum is broader than high. It differs from that of *Dromæus* in its rather more prominent neural spine and much smaller hypapophysis, in its larger vertebrarterial canal, and in the presence of an interzygapophysial foramen; from that of *Rhea* in its much smaller hypapophysis and larger vertebrarterial canal, the form of the neural arch being very similar in the two birds; from that of *Dinornis* in its much smaller hypapophysis, the form of its posterior articular surface, the shape of the odontoid process and its articular surfaces, and in the rudimentary condition of its anterior zygapophyses.

The third vertebra, seen from above, has the usual quadrate form, but the width is greater than the length as in *Dinornis*, instead of the reverse as in *Struthio*. The anterior articular face of the centrum looks completely downward; it is much narrowed in the middle by a fossa which forms a deep emargination in its hinder border. The posterior articulation is similar to that of the axis, but wider in proportion to its height. The ventral surface, deeply concave from side to side in front, becomes narrower posteriorly and bears a hypapophysial keel. The anterior and posterior zygapophyses are both large and nearly equal in size, and there are large hyperapophyses over the posterior ones. The interzygapophysial bar is broad and there is an interzygapophysial foramen. The neural spine consists of a broad basal platform, increasing in height posteriorly and bearing on its posterior surface a pit for ligament. Superiorly it is bifid, rising into two prominent tuberosities separated from one another by a deep groove. Between these processes and the hyperapophyses there is a broad valley.

The fourth vertebra is very similar to the third, except that the posterior articulation of the centrum is broader. The fifth is also similar, but the neural spine is rather higher. In vertebræ 4–6 the anterior zygapophyses look upward and forward, making an angle of about 45° with the long axis of the column; they are not directed at all inwards. In the sixth the transverse bar of the neural spine is reduced, while its bifid extremity increases in height; at the same time the spine is shifted towards the anterior border of the neural platform, which here commences to increase in length; the hyperapophyses are much smaller, and the interzygapophysial bar is reduced. In the centrum the articular surfaces are much broader than high, and the hypapophysis is reduced to a small ridge near the middle of the ventral surface. The seventh is similar to the sixth, but shows traces of the narrowing of the posterior region of the neural platform, which is the most remarkable character of the eighth.[1] In the eighth the anterior half of the neural platform is more than twice as wide as the posterior. The neural spine, as before, consists of a basal portion bearing a bifid extremity; but it is farther forward and is united on either side to the hyperapophysis by an oblique ridge. The posterior zygapophyses now look outward as well as downward and backward. The centrum is very broad, and there is no trace of a median hypapophysis. In the ninth the neural spine is represented only by the anterior portion of the ridges (neural or postzygapophysial), which run forward from the hyperapophyses, converging towards the middle point of the anterior margin, where they meet in a slight prominence; in the angle between these ridges there is a deep pit for ligament. Behind the anterior zygapophyses there is a pocket-like fossa, into which open pneumatic foramina.

The next ten vertebræ resemble the ninth in general character. The chief modifications that are perceptible in the successive

[1] It may here be remarked that it is possible that a vertebra too many may have been used in reconstructing this anterior portion of the neck.

vertebræ are—(1) The neural or postzygapophysial ridges become higher and at the same time do not extend so far forward. (2) On the eleventh there are small paired hypapophyses on the ventral surface of the centrum; in the twelfth these unite, forming a low median tuberosity, which increases in height to the seventeenth, behind which it also increases in antero-posterior extent, until on twenty and twenty-one it forms a keel more than half the length of the centrum. In all these vertebræ the centrum is broad and the articular faces much wider than high.

On all the cervical vertebræ the fused ribs are very broad, and enclose a large vertebrarterial canal.

The next vertebra (21) is the first with a free rib, and both it and the succeeding two may be regarded as cervico-dorsals. In these the anterior portion of the neural ridges are united by a broad base and again rise to form a bifid neural spine. In the last cervico-dorsal, however (23), the basal portion of the spine increases in height, while the bifid part is relatively smaller; in the next (24) the spine is a massive quadrate structure, which shows only a trace of the bifid condition at its upper end, and in the following vertebræ it increases in height and antero-posterior extent. In all the dorsal vertebræ the spine bears on its anterior, posterior, and lateral surfaces vertical ridges, which in their lower portion expand into thin buttresses of bone: of these the anterior runs forward to the middle point of the anterior border of the neural arch, the lateral outward to the diapophysis, the posterior, which is the smallest, to the middle point of the posterior border of the arch. On 23–28 inclusive there is also a pair of postero-lateral buttresses which run outward and backward on to the posterior zygapophyses; in 23–26 these ridges terminate in a small hyperapophysis: they are homologous with the posterior portion of the neural or post-zygapophysial ridges. In all these vertebræ between the bases of these plate-like buttresses there are deep pocket-like fossæ.

In the cervico-dorsal and dorsal series the diapophyses become less massive and project farther laterally as we pass backwards, and at the same time the pneumatic fossa occurring at their base increases in size. In these vertebræ the antero-lateral margin of the centrum forms a prominent lip which bears a deep capitular facet; in the cervico-dorsals this is circular, in the dorsals it is elongated from above downward and forward. These vertebræ have on their ventral surfaces prominent keel-like hypapophyses, which in the posterior ones are directed forward and occupy almost the whole length of the centrum.

The first pelvic vertebra has a high massive neural spine, the quadrate upper end of which is exposed between the divergent anterior ends of the ilia. Its transverse process is single (diapophysis), and unites with the ilia by its expanded outer end: it bears a facet for the tubercle of the free rib, the head of which articulates with a facet on the anterior margin of the centrum. There is some indication of a median hypapophysis, and both the side of the centrum and the base of the diapophysis are perforated by large

pneumatic fossæ, which are separated only by a thin horizontal plate of bone. In the second pelvic the top of the neural spine is completely fused with the ilia, as also are those of the other preacetabular vertebræ, thus forming a high iliac crest, which is convex from before backward. The second vertebra also has only the diapophysis developed, and bears a free rib; there is in this case a well-marked blunt hypapophysis. In the third the costal element is fused with both the diapophysis and parapophysis, and forms a pointed process projecting below the ventral margin of the ilium. The next three vertebræ have double transverse processes. As far back as this point (i.e., to the hinder border of the sixth pelvic vertebra) the ventral surface of the sacrum is convex from side to side, and its long axis is nearly straight, but behind this it becomes concave from side to side and strongly convex from before backward, and opposite the origin of the free portion of the ischium it turns sharply dorsad and then again runs backward nearly in a straight line, sloping somewhat upwards. The ventral convexity occurs at the level of the acetabulum, and the vertebræ of this region are fused into a solid mass, the only traces of the compound origin of which are a few small foramina, which mark the intervals between the parapophyses, the outer ends of which are completely co-ossified with the pubes and ischia, with the ventral surface of which the ventral surface of the sacrum forms a continuous curve.

The pelvic vertebræ posterior to the convexity are six or seven in number. They bear broad, thin, transverse processes, of which the two or three anterior ones slightly overlap one another, and the outer ends expand and unite closely with the thickened inner border of the ilia. The ventral surface of the centra of the anterior ones is convex from side to side, but that of the posterior is flat or even slightly concave. In these posterior vertebræ the transverse processes and the neural spine form a continuous nearly semicircular plate of bone, which is convex in front and concave behind, and the outer edge of which unites firmly with the ilia. The anterior free caudals are similar in structure; their centra are procœlous and perforated ventrally by a pair of pneumatic foramina: a pair of foramina also penetrate the base of the transverse process. In the more posterior caudals the massive neural spine and transverse processes are not united into a common plate of bone, and the ventral pneumatic foramina are wanting; their centra are deeply cupped in front.

In the pelvis the preacetabular portions of the ilia are inclined to one another at a very acute angle; as already mentioned, they fuse along their dorsal margin with the tops of the neural spines of the anterior pelvic vertebræ, thus forming a high massive iliac crest, convex from before backward. At about the level of the acetabulum the ilia begin to diverge and are divided by a prominent angular ridge into a superior surface, which together with the broad united upper ends of the neural spines forms a wide pelvic escutcheon, and a lateral surface which is nearly vertical. The pelvic escutcheon is convex from side to side and is constituted

mainly by the expanded upper portions of the neural spines of the sacral vertebræ, the original divisions between which are indicated by an outer and inner row of inter-osseous foramina, the outer marking the boundary between the vertebræ and the ilia, the inner running close to the middle line; between the two there is a shallow depression with sharply defined margins, which seems as if it may have lodged an ossified tendon. The ilia terminate posteriorly in an angle which lies some distance behind the last fused caudal vertebra. The nearly vertical external surface is extended downward as a thin flange of bone, the straight lower edge of which is, in one specimen, almost in contact with the straight upper margin of the expanded portion of the ischium; this ventral flange extends some distance below the centra of the fused caudal vertebræ. The acetabulum is large and its anterior edge is produced outward into a prominent preacetabular process. The ischium is proximally a trihedral rod, but its distal portion is greatly widened by the presence of wing-like expansions of its upper and lower borders, the upper being much the larger and, in one specimen, having for some distance a straight upper border which is nearly in contact with the ilium, the two bones being separated only by a narrow slit for about 12 cm.; the greatly expanded distal portion extends some distance behind the ilia. The ischium also bears on its ventral margin a small process, which nearly meets the pubis and closes the obturator foramen.

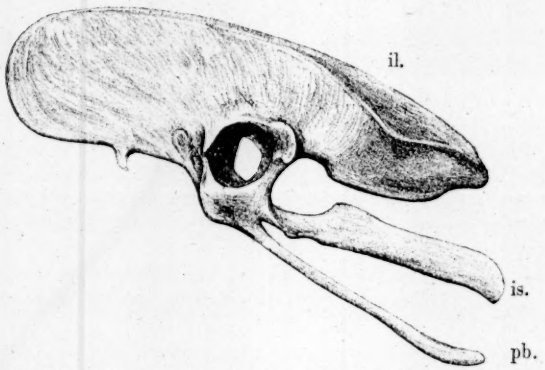


Fig. 2.—Pelvis of *Æpyornis Hildebrandti*, Burckh.; reduced to between one-eighth and one-ninth nat. size. *il.* = ilium, *is.* = ischium, *pb.* = pubis. (In another pelvis the distance between the ilium and ischium is only three millimetres at the narrowest point.)

The pubis is a long curved rod, triangular in section, with one of the sides of the triangle forming the external surface. For a great part of its length the upper and lower angles are produced into narrow thin plates of bone; distally the bone is somewhat expanded. Both the pubis and ischia of opposite sides diverge from one another, so that the posterior opening of the pelvis is very wide.

There seem to have been ten pairs of free ribs: the first three,

borne on vertebræ 21–23, are not connected with the sternum, to which the next four are joined by sternal elements. The last dorsal bears a free rib, as also do the first two pelvic vertebræ. On none of the ribs are there any uncinate processes.

The ratite sternum is of very peculiar form, and has undergone great reduction. It is a thin plate of bone, very wide from side to side, and extremely short from before backward, especially in the middle line. It has well-developed coracoid grooves and prominent antero-lateral processes, at the base of which pneumatic foramina open. It is very unlike the sternum of any other ratite bird except *Apteryx*, but this similarity is probably due to the fact that in both cases the bone has undergone extreme retrogression.

The sternum has been figured on pl. ix of the above-mentioned paper.

The coraco-scapula is not unlike that of *Casuarius*. It consists of a broad ventral plate, the *coracoid*, and a dorsal curved rod-like region, the *scapula*, the two making a very obtuse angle with one another, and being completely fused in the adult. The coracoid is perforated in its upper portion by a large supracoracoid foramen, and articulates with the coracoid groove of the sternum by a long straight ventral border. There is a blunt precoracoid process. The upper extremity of the scapula is flattened and somewhat expanded. On the outer border of the compound bone, at the junction of the two elements, there is a small but very clearly-marked glenoid cavity. The coraco-scapula has been figured loc. cit., p. 386, fig. A.

The wing in these birds was reduced to a mere rudiment, and probably scarcely any trace of it was visible externally. The *humerus* is a short rod of bone, the upper end of which bears a rounded articular head and a mere trace of the pectoral crest. The lower end has not the usual surfaces for articulation with the radius and ulna, but only a single one. The remainder of the wing is not certainly known, but in Dr. Forsyth Major's collection there is a bone which I believe to represent the radius, ulna, metacarpus, and phalanges, greatly reduced and fused into a common mass. This remarkable structure bears on its thickened proximal end an articular cup, into which the distal articulation of several of the rudimentary humeri fits very well. Just beyond the articular end the outer surface bears a deep depression in the middle line, indicating, as I believe, the position of the division between the radius and ulna. Distally the bone becomes thin and plate-like, and terminates in an irregular bifid extremity; this portion probably consists of the last remnants of the metacarpus and phalanges.

The complete bones of the hind limb from Sirabé have never been heretofore described and figured, with the exception of the metatarsus, but I can only refer briefly to them on this occasion. The femur is a stout massive bone, of which the head is nearly spherical and the neck short and thick. The trochanter is very large; its upper surface slopes steeply up from the neck, and rises high above

the head; anteriorly it forms a very large projection. The upper part of the shaft is rounded, but farther down it becomes somewhat flattened from before backward. The condyles project far forward, and the outer extends considerably below the inner. There is a deep popliteal fossa into which pneumatic foramina open; there is also, in most cases, a pneumatic opening at the upper end of the bone on the posterior surface. In the tibio-tarsus there is a large cnemial crest, which rises considerably above the proximal articular surface. The shaft is compressed from before backward, and its anterior face is much flattened, particularly in its lower half; there is no bony extensor bridge. The distal articulation is very broad, and the two condyles are not separated by a deep intercondylar groove, but form a continuous cylindrical surface.

In the metatarsus the proximal articular surface is very wide from side to side, and narrow from before backward: there is no intercondylar tubercle. The hypotarsus is simple, and forms a very high ridge on the posterior surface of the upper portion of the bone. The anterior face is deeply concave above, but narrows and becomes nearly flat anteriorly a little above the distal articulation. The trochleæ are very large: the inner arises at a somewhat lower level than the outer, and extends farther downward. There is no perforation for the tendon of the adductor of the outer digit.

The toes of the present specimen seem to be relatively rather too small, although some of the largest phalanges were used for their reconstruction. The phalanges are compressed from above downward in the middle and outer toes, while in the inner they are more cylindrical. The ungual phalanges are broad, slightly curved, bluntly pointed claws. In the collection no bones that can be regarded as having belonged to a hind toe occur, but the markings on the hinder surface of the metatarsus seem to show that at least a rudimentary hallux must have been present.

Some approximate measurements of the skeleton as mounted are given below :—

	cm.
Height to top of crest of ilium	116
Height to middle of acetabulum	96
Height to top of skull	158
Length of femur	31
Width of lower end of femur	12
Length of tibio-tarsus	56·5
Width of lower end of tibio-tarsus	10·5
Length of metatarsus	29
Width of upper end of metatarsus	11
Width of lower end of metatarsus	10·5
Width of middle trochlea	4·5
Length of ilia	56
Width of pelvis at anti-trochanter	25
Least preacetabular width	17·5
Length of free portion of ischium	28·5
Distance between distal ends of ischia	30
Distance between distal ends of pubes	33
Height of first pelvic vertebra	17

II.—*Baltoceras*, a new genus of the Family Orthoceratidæ.

By Gerhard Holm.

A NEW Cephalopodan species, *Endoceras Burchardii*, was described in 1880 by Dewitz,[1] who considered this species as a very typical *Endoceras*. A description and diagram of its ectosiphon is given in the introductory description of the siphon of *Endoceras* as an example of a typical *Endoceras*-siphon. In *Endoceras Burchardii* each septum, according to Dewitz,[2] forms a septal tube (funnel), extending backwards to the next septum, into the septal tube (funnel) of which a small part of it enters.

Rüdiger[3] has also described this species as an *Endoceras*, and I have myself, on the authority of Dewitz, occasionally mentioned it under this name. Having had, however, many opportunities of seeing it in the island of Öland, where it is pretty common in the grey *Lituites* Limestone, I have long since been surprised to find that detached siphons of it—without reference to its size or its marginal position—far more resemble the siphon of an *Orthoceras* than that of an *Endoceras*, not only as to shape but also as regards substance and colour. Like a siphon of an *Orthoceras*, detached by weathering, it never shows any septal fractures,[4] but immediately behind each septum there is a narrow, deep, groove-like contraction, sharply defined in front as well as behind. In figures 2 and 2*a*, taf. xvi, Dewitz, this can be seen very distinctly. Rüdiger, too, has noticed this siphonal form, so exceptional in an *Endoceras*, and describes it thus: "Die Erweiterung der Düten erstreckt sich über den ganzen Zwischenraum zweier Kammerscheidewände, so dass der Sipho nur an der Durchbruchsstelle der letzteren eingeschnürt erscheint und, isolirt, einer Reihe Semmeln ähnelt." Nor does the weathered siphon consist of a firm shell-substance, but always presents itself more or less decomposed, the surface being of an earthy appearance, like that of an *Orthoceras*. Having commenced some time ago to prepare thin sections of a series of species in order to study microscopically the siphons of the Lower Silurian Cephalopods, I was deeply interested as I looked forward to the first section of *Endoceras Burchardii*, and I was not astonished to find its siphonal structure entirely different from that of *Endoceras*; instead, it was quite similar to the siphon of a species belonging to the group *Ellipochoanoida*, Hyatt.

The following illustrations, Figs. 1 and 2, drawn from sections, show the structure of the ectosiphon. The septa, together with the short septal tube (funnel), consist of two layers; one thicker in the middle, of water-clear, colourless calc-spar, on both sides of which

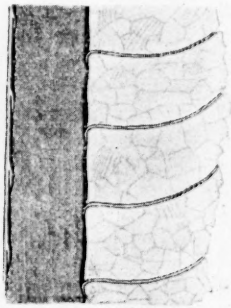
[1] Dewitz, H., "Ueber einige ostpreussische Silurcephalopoden": Zeitschr. d. Deutschen geolog. Gesellschaft, vol. xxxii (1880), p. 391, taf. xvi, figs. 2, 2*a*.

[2] Ibid., p. 371, fig. 1, "Schematischer Längsschnitt in der Mittelebene."

[3] Rüdiger, H., "Ueber die Silur-Cephalopoden aus den mecklenburgischen Diluvialgeschieben," p. 29: Separatdr. aus Arch. der Freunde d. Naturg. Meckl. 1891.

[4] Holm, G., "Om de endosifonala bildningarna hos familjen Endoceratidæ": Geol. Fören. Förh., Bd. xvii (1895), p. 607.

there is a thin opaque layer of a light greyish-yellow colour. The septa, therefore, corresponding to the different layers, are white in the figures, with black boundary-lines. The wall connecting the



Endoceras Burchardii, Dew. The island of Öland, Grey *Lituites* Limestone.

Fig. 1.—Tangential section through the middle of the siphon. The plane of the section is not exactly at right angles to the middle plane of the conch, nor is it exactly parallel to the longitudinal axis of the siphon. The latter circumstance is the reason why the siphon appears to taper towards the distal end. Drawing after a photograph. Enlarged three diameters.

Fig. 2.—Section in the middle plane. Enlarged two diameters.

septal tubes (funnels) is of about the same colour and appearance as the outer layers of the septa (like them black in the figures). The loculi are filled with coarse-grained calc-spar; the siphon with the rocky substance. The septal tubes (funnels) are short, and extend only the fifth of the distance to the next septum, ending in a sharp edge. The intervening connective wall is thicker than the septa, opaque, sharply defined inwards, while the outside, even where the specimens are not weathered, is decomposed, having no even or clear-cut surface. At the posterior part it attaches itself to the inner side of the posterior septal tube (funnel); in the anterior part it encloses the outer side of the anterior septal tube (funnel). The strictures and the peculiar appearance of loose siphons is thus easily explained, as the siphon between the septal tubes (funnels) is easily removed from the enclosing stone and from the short septal tubes (funnels). The strictures are therefore impressions from the septal tubes (funnels).

In spite of its apparent resemblance to *Endoceras*—through the comparatively large and marginal siphon (diam. $\frac{2}{5}$–$\frac{2}{7}$ of that of the conch)—it appears that the species above described, considering the structure of the ectosiphon, does not even belong to the same subdivision (*Holochoanoida*, Hyatt) of Nautiloidea as *Endoceras*, but has its nearest relations in the family Orthoceratidæ of the subdivision *Ellipochoanoida*, Hyatt. It follows that even within the latter family there must occur species with a large marginal siphon, although they have been overlooked on account of their apparent

resemblance to *Endoceras*-forms. It being impossible to refer these species to any genus hitherto described, *Endoceras Burchardii* may be considered as the type of a new genus. As a suitable name I propose *Baltoceras*, as the species of this genus appear in the Baltic Silurian. *Baltoceras Burchardii* (Dew.) is found in the Lituite Limestone in the island of Öland and in Dalarne, as well as in the corresponding horizon (Schicht C_1) of Esthonia, where I have discovered it at Kandel, and at Hirro, near Reval.

In the grey *vaginatum* Limestone in the island of Öland, and in Dalarne, I have found a closely connected form with perfectly identical structure of the ectosiphon, but with shallower loculi.

In this connection it may be mentioned that there is reason to suspect that *Endoceras*, nov. sp., and *Endoceras angustisiphonatum* of Rüdiger,[1] far from belonging to the genus *Endoceras*, in reality are some forms of *Orthoceras*, with marginal or submarginal siphon.

III.—On a New Section in the Middle Lias of Lincoln.

By John H. Cooke, F.G.S.

THE quarrying operations that have been carried out during the last five years at Handley's Pit, Lincoln, have led to the exposure of some very complete and instructive sections in the Middle Lias.

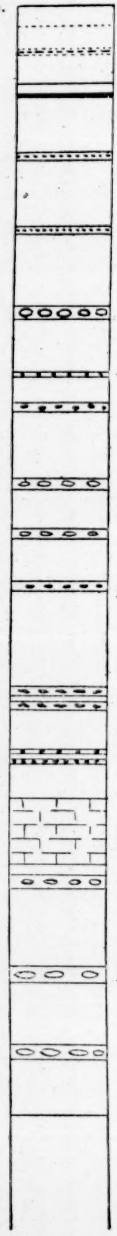
Handley's Pit is situate on the North Cliff, at a distance of about a furlong from the now disused pit of Glaisiers, and immediately below that of the Lincoln Brick Company (late Swan's). When compared with the sequence exposed in Swan's Pit, it affords some interesting details that assist materially in clearing up some of the doubtful points to which Mr. Dalton referred in the Geological Survey Memoir on Lincoln Geology[2] regarding the limitation of the range of *A. margaritatus*, and the occurrence of the Marlstone Rock-bed in the Lincoln District.

The general facies of the rocks exposed is a series of layers of arenaceous shales, clays, limestones, and ferruginous nodules, following one another rapidly and conformably, and having a dip of 5° E. and 30° N. The line of dip as shown in the fall of the section is, however, much distorted, a fact which is due partly to the presence of a number of small faults, and partly to the unequal shrinkage which the shales and clays probably underwent during the processes of lithification. The following is the sequence that the strata in this pit at present exhibit, the total thickness of which is 35 feet 3½ inches. (See p. 254.)

Many of these layers, however, are not persistent even over short horizontal distances, and hence it is that no two pits in the district offer the same sequence in their sections, and even in the same pit they vary as the work of excavation proceeds. Mr. W. D. Carr[3] remarks that at Lincoln the "Marlstone Rock-bed is entirely absent," and

[1] Loc. cit., pp. 36–7, taf. i, figs. 5*a–b*; taf. ii, figs. 10*a–b*.
[2] Memoir of the Geological Survey, sheet 83, pp. 24 and 25.
[3] W. D. Carr, "The Lincoln Lias": Geological Magazine, April, 1883.

SECTION OF STRATA EXPOSED IN MIDDLE LIAS AT HANDLEY'S PIT, LINCOLN.



Ref. No.	ft.	in.		
	1	6	"Fish and Insect" Limestones.	*A. serpentinus.*
	5	0	Shale.	
		6	Nodules.	
	6	0	Shale.	
			Line of demarcation between Upper and Middle Lias	
1	2	0	Yellow Clay.	*A. spinatus?*
2		4	Doggers.	
3	2	6	Yellow Clay.	
4		4	Doggers.	
5	2	6	Yellow Clay.	
6		1½	Thin Doggers.	
7	2	6	Yellow Clay.	
8		1	Nodules.	
9	1	0	Blue Clay.	*Range of Amaltheus spinatus.*
10		3	Septaria.	
11	2	6	Clay.	
12		4	Doggers.	
13	1	8	Clay.	
14		4	Doggers.	
15	1	8	Clay.	
16		4	Septaria.	
17	4	0	Clay.	
18		3	Septaria.	
19		3	Clay.	
20		3	Septaria.	
21	1	3	Clay.	
22		2	Septaria.	
23		3	Clay.	
24		2	Phosphatic Nodules.	
25		9	Clay.	
26	1	7	Limestone (Marlstone).	
27		4	Clay (Belemnite and Pecten Bed).	
28		5	Phosphatic Nodules.	
29	2	6	Clay.	
30		4	Septaria.	
31	2	0	Clay.	*Range of Amaltheus margaritatus.*
32		4	Septaria.	
33	2	0 +	Clay.	

he notes that "its disappearance is remarkable as it is known at Leadenham, ten miles to the south, though rapidly thinning out, and it occurs also some distance north of Lincoln."

It was this impersistence that lead Mr. Carr to infer the entire absence of this bed at Lincoln. As I shall presently show, however, the Marlstone occurs both in this and in the adjoining disused pit of Glaisiers. But although the sequence of the beds in the different pits varies so much, little difficulty is experienced in determining in a general way the equivalence of conditions in the different localities, as there are several horizons, e.g. layers 11, 17, and 18 to 30 (see section, p. 254), that are strongly marked, and as far as I have been able to determine they are also fairly constant.

In the cutting that has recently been made on the slopes that intervene between the pit of the Lincoln Brick Company and that of Handley, the top bed of the Middle Lias, which is overlain by the basement "Fish and Insect" Limestones of the Upper Lias, is well exposed. This "Fish and Insect" bed consists of a stratum of soft ferruginous, arenaceous, finely laminated, and very fissile limestone of a yellowish colour, weathering grey. It has associated with it numbers of compact limestone nodules that are traversed with minute veins of calcite, and crowded with the remains of small corals (*Astrea*), *Belemnites*, *Ammonites annulatus*, *Discohelix aratus*, and small Gasteropods (*Turritella* and *Chemnitzia*).

The bedding planes of the limestone are crowded with the casts and shells of *Inoceramus dubius*, Sow , and also with great quantities of golden-coloured particles of the shells of this mollusc that bear in some cases a strong resemblance to the scales of fishes and the wings and elytra of beetles. Casts of *Astarte*, sp., *Lima*, sp., the burrowings of Annelids, and fragments of calcified and pyritized wood, are also common. The Ammonites and Gasteropods are often found filled with calc-spar.

Beneath this lies a bed of blue shaly clay that is highly pyritous and thinly laminated, and has an intercalated band of ferruginous limestone nodules. These nodules are very rotten, and having a concentric structure they readily peel and break up. They are quite unfossiliferous. The pyritous state of the shale does not appear to have been favourable to the preservation of fossils, and notwithstanding a careful search I was unable to find any traces of organic life.

At the bottom of this cutting the tram-lines have been laid on a bed of soft ferruginous sandstone that varies considerably in its petrological characters. At the north end of the cutting it is compact and massive; at the south end it is very soft and friable. This sandstone readily splits into thin slabs, the bedding planes of which show *A. spinatus*, *A. serpentinus*, *A. Thourense*, *Belemnites clavatus*, *Ditrupa liassica* (five inches long), and casts of *Lima*, *Pecten*, *Leda*, *Cardium*, and *Nucula*.

Below this is a series of alternating beds of clays, shales, nodular seams, and limestone bands, but in none of them are the conditions favourable to the preservation of organic remains.

In Handley's Pit four phases of shale deposits are exposed within a vertical range of 15 feet; and each is separated from the other by a line of ferruginous septaria. When freshly cut, the shales are of a dark-blue colour, but on exposure they weather to a light-grey. In composition they are decidedly argillaceous, with an admixture of carbonate of lime, of mica, and of considerable quantities of iron and silica. The carbonate of lime consists for the most part of the tests of foraminifera, the most predominant of which are *Cristellaria, Nodosaria, Cytheridea*, and *Cytherella*.[1] As a rule the shales are not rich in fossils, although pyritized wood and lignite are very common. In these latter the ligneous structure is always very marked, and when fractured they readily split in the direction of the fibre.

It is not possible in a general statement to give the thickness of these shale beds, as they vary so much at different points; the thickness in the section given on p. 254 represents the beds in the centre of the pit, and is on the whole a fair average.

The septaria in beds 6, 8, and 10 are much decomposed, and like the clays in which they lie, they contain but few traces of fossils. But those in 18, 20, 22, 24, 28, and 30 offer, in these respects, marked contrasts. Externally they present much the same appearance in size and shape. They are, however, more compact, and on being fractured are found to contain a nucleus of claystone, which has imbedded in it other small nodules, and the shells of *Lima, Plicatula, Pecten, Ostrea*, and *Avicula*, many of which are often invested in a pyritic matrix.

The most marked feature in the section exposed in this pit is the limestone course 25. It runs right across the face of this pit and crops out again in the adjoining Glaisiers Pit. It immediately overlies the "ferruginous nodular band," to which Mr. W. H. Dalton refers when he says: "Both at Lincoln and Grantham, whilst specimens of *A. margaritatus* have been obtained beneath this ferruginous nodular band, no signs of that fossil were observed above it, so it seems to form the upward local limit of the zone or range of *A. margaritatus*."

A. margaritatus occurs both in this limestone course and in the overlying six feet of shales, clays, and septaria, so that, as far as the Handley's Pit shows, the upward limit of *A. margaritatus* is eight feet above the "nodular band."[2] This limit is represented by the band of septaria which is marked 16 in the section. The limestone bed 25 is of a markedly argillaceous character. It is very hard and compact, and varies in thickness from 1 ft. 6 in. to 2 ft. Its fracture is very irregular, and, in places, it is frequently traversed by minute veins of calcite that cut the rock in all directions, while in others it contained masses of "dog-tooth" and "nail-head" calc-spar.

Its colour varies from a dark-grey to a light-blue, but after

[1] For the determination of the Foraminifera from these shales my thanks are due to Mr. F. Chapman, F.R.M.S.

[2] My observations have been confirmed by the Rev. E. Nelson, who has also collected *A. margaritatus* from bed 16 downwards.

weathering it exhibits many iron stains. In places it passes into a typical ironstone rock, or is sandwiched between two thin layers of iron-pyrites, both of which have imbedded in them representatives of all the fossils that are to be found, either in the limestone course or in the subjacent and superposed clays and shales. More fossils are to be obtained from these pyritic layers than from any other part of the formation.

Foraminifera are most abundant, and a considerable part of the bed is made up of the tests of *Bairdia liassica*, and oolitic grains of oxide of iron of the size and appearance of millet-seed. Referring to this bed, which was then very imperfectly exposed in Glaisiers Pit, Mr. W. D. Carr described it as a "soft ferruginous, clayey sandstone, with occasional casts of shells that do not help in determining the horizon." I have before referred to the finding of *A. margaritatus* in it, in abundance, by the Rev. E. Nelson and myself. I also obtained from it *R. tetrahedra*, which would seem at once to determine its equivalence with the Marlstone, that has hitherto been supposed to have been missing in this neighbourhood.

The septaria in 22, 24, and 28 vary considerably from those in other parts of the section. They are smooth, depressed, spheroidal masses of hard claystone. Most of them contain specular iron. Incipient fracture lines that extend partially throughout their mass, and that exhibit in their fractured facets layers of powdery, ferrous oxide, are a common feature.

As a rule the fossils are found attached to the exterior of the nodule, and are frequently filled with calcite; but *A. margaritatus* and *A. spinatus* are more frequently found within and forming the nucleus of the nodule.

Another interesting characteristic of the two septarian layers 24 and 28 is the abundance of phosphatic nodules that are contained in them. These nodules are smooth, polished masses of phosphates of lime and alumina, and they vary in size from a small pea to a walnut. They are of all shapes—some being symmetrically elliptical, oval, and circular, whilst others are most irregular in outline. In colour they are uniformly of a light chocolate colour. Sections under the microscope showed that nearly all of them have a nucleus of organic matter; sometimes a shell fragment, but most frequently it consists of the tests of Foraminifera—*Cristellaria*, *Nodosaria*, and *Lagena*.

Immediately beneath the limestone course 26 is an irregular seam of light-blue shaly clay (27), of a marked micaceous and ferruginous aspect. It is chiefly remarkable for the enormous numbers of Belemnites (*B. clavatus*, *B. vulgaris*, and *B. longiformis*) that it contains. In some places they are so thick that the bed is almost entirely made up of them.

The line of junction between these Belemnite shales and the limestone is also extremely prolific in molluscan remains. Shells and casts of *Astarte*, *Lima*, *Cardinia*, *Gresslya*, *Pecten*, *Nucula* occur in masses with other, though less numerous, shells of *Eucyclus*, *Eulima*, *Cerithium*, *Ostrea*, *Plicatula*, and *Modiola*.

From the foregoing details it will be observed that in this section *A. margaritatus* has a higher range than has hitherto been ascribed to this fossil in the Lincoln Lias; and for a vertical distance of 15 feet the zones of *A. spinatus* and *A. margaritatus* overlap (vide section layers 16 downward to 30). This, and the well-marked line of demarcation between the Upper and the Middle Lias, as well as the reappearance of the Marlstone series, mark this as one of the most interesting sections in the Lincoln District.

The following is a list of the fossils that I have collected from this pit:—

Synoptical List of the Fossils found in Handley's Pit (Middle Lias).

	Zone of *A. spinatus*, Layers 1 to 16.	Zone of *A. spinatus* and *A. margaritatus* (mixed), Layers 17 to 30.	Zone of *A. margaritatus*, Zone 31 to bottom.
Plesiosaurus, sp.		*	
Amaltheus margaritatus, Mont.		*	*
A. Engelhardti, D'Orb.		*	
A. solitarius, Simp.		*	
A. spinatus, Brug.	*	*	
Nautilus (4 specimens)		*	
Belemnites clavatus, Blainv.	*	*	*
B. inæqualis, Simp.		*	
B. vulgaris, Y. and B.		*	
B. longiformis, Blake	*	*	
Cerithium, sp.	*		
Eucyclus imbricatus, Sow.		*	
Eulima, sp.	*		
Dentalium elongatum, Münst.	*		
Dentalium, sp.		*	
Ostrea irregularis		*	
Ostrea, sp.	*		
Pecten æquivalvis, Sow.		*	
Pecten (several sp.)		*	
Lima pectinoides, Sow		*	*
Lima (several sp.)		*	
Plicatula liasina, Terq.		*	*
P. spinosa, Sow.		*	
Monotis cygnipes, Y. and B	*	*	
M. inæquivalvis, Sow.		*	
Gervillia, sp.		*	
Inoceramus, sp.		*	
Pinna, sp.		*	
Modiola scalprum, Sow.	*	*	
Cucullæa, sp.	*	*	
Nucula, sp.	*	*	*
Leda galathea, D'Orb.		*	
Lucina, sp.			*
Unicardium, sp.		*	
Astarte, sp.		*	
Cardinia crassiuscula, Sow.			*
Pholadomya ambigua, Sow.		*	*
Goniomya V*-scripta*, Sby.		*	
Gresslya intermedia, Simp.		*	*
G. donaciformis, Phill.	*	*	
Pleuromya costata, Y. and B.		*	
Ceromya, sp.	*		
Homomya, sp.		*	

	Zone of *A. spinatus*, Layers 1 to 16.	Zone of *A. spinatus* and *A. margaritatus* (mixed), Layers 17 to 30.	Zone of *A. margaritatus*, Zone 31 to bottom.
Quenstedtia, sp.	*		
Gryphæa, sp.		*	
Sphæra (*Corbis*)	*		
Terebratula, sp.		*	
Rhynchonella tetrahedra, Sow.		*	
Rhynchonella, sp.		*	
Cythere, sps.		*	
Cytherella, sps.		*	
Pentacrinus, sp.		*	
Nodosaria mucronata		*	
N. pauperata, D'Orb.		*	
N. consobrina, D'Orb.		*	
N. raphanus, Lin.		*	
Cristellaria recta, D'Orb.		*	
C. varians, Born.		*	
C. crepidula, F. and M.		*	
Marginulina raphanus, L.		*	
Frondicularia excavata, Terq.		*	
Amnodiscus incerta, D'Orb.		*	
Scalpellum, sp.		*	

Fossils found at the Base of the Upper Lias immediately above Handley's Pit.

Ammonites serpentinus.
A. Thourense.
A. annulatus.
Chemnitzia, sp.
Astarte, sp.
Dentalium elongatum.
Inoceramus dubius.
Cerithium, sp.

IV.—On some Fossil Entomostraca from South America.

By Professor T. Rupert Jones, F.R.S., F.G.S.

(PLATES X and XII.)[1]

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§ v. Philippi, 1887.
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§ vii. *Estheria Aricensis*, sp. nov.
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§ xi. *Estheria Mawsoni*, sp. nov., and var.
§ xii. Ostracoda.
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PART I.

§ I. Introduction.

There are now in the British Museum (Natural History Branch) several specimens of fossil *Estheriæ* from South America, beside

[1] Pls. X and XI will appear in the July Number with the second part of this paper.

those described and figured in the "Monograph of Fossil *Estheriæ*" (Palæontographical Society), 1862, pp. 109–111, pl. iv, figs. 8–11.

1. There are some from the same locality as those already dealt with, namely, *Estheria Forbesii*, Jones, from Cacheuta in the province of Mendoza, Argentine Republic.

2. Others collected by David Forbes at another place, namely, Arica,[1] Department of Arequipa, in Southern Peru.

3. An interesting series from Brazil; partly described and illustrated in the Geological Magazine for May, 1897, pp. 195–202, Pl. VIII.

From Cacheuta and Challao (both in the province of Mendoza) more or less similar specimens have been described by H. B. Geinitz and R. A. Philippi; and the latter has treated of a species, probably from the district of Lebu, Chili, like that which Dr. Forbes found at Arica. These, therefore, have to be compared. The Brazilian specimens referred to above belong to four new species, including three of *Estheriïna*, gen. nov., elsewhere described.

The close similarity that many *Estheriæ* have one to another in the shape of the carapace, the only part of the animal remaining, when fossil, for the geologist to examine, makes the determination of fossil species very difficult. The limbs and soft parts having perished, the features of the valves, such as shape and contour, the lines of growth and their interstices, are all that give the means of judging specific differences. In the more or less crushed or otherwise modified state in which the fossil carapaces often occur the difficulties are multiplied.

The sex of individuals influences the carapace; and the successional stages of growth are accompanied by differences of outline. Many such modifications and variations of form are recognizable in published works treating of these Phyllopods. For example, G. O. Sars, of Christiania, has well illustrated and explained the gradational changes, from the egg to the adult form, in *Cyclestheria Hislopi*[2] and *Estheria Packardi*.[3]

§ II. Geinitz, 1876.

In 1876 Professor Dr. H. B. Geinitz described and figured several fossil *Estheriæ* from the Rhætic carbonaceous shales and associated dark-grey clays of Challao and elsewhere in the Mendoza province, Argentine Republic. All these specimens he referred to *Estheria Mangaliensis*, Jones: see "Beiträge zur Geologie und Palaeontologie des Argentinischen Republik," II, Palaeontologischer Theil, Abth. 2; "Ueber Rhaetische Pflanzen- und Thier-Reste in den Argentinischen Provinzen La Rioja, San Juan, und Mendoza," 1876, p. 3, pl. i, figs. 1–6.

[1] Now held by the Chilians as an indemnity for war expenses, or taken by them in 1886.

[2] Christiania Vidensk.-Selsk. Forhandl. 1887, No. 1.

[3] Archiv Math. og Naturv. Attende Bind, Förste Hefte, June, 1896, Kristiania. In this memoir on *E. Packardi* is given the complete history of the growth of an *Estheria* and its valves.

He states that "In the Universal Exhibition at Paris in 1867, the Argentine Republic exhibited bituminous shales (Brandschiefer), containing numerous shells of an *Estheria*, together with other bituminous substances, such as 'Carbon de Piedra,' from the district of San Lorenzo, province of Mendoza. Professor Stelzner has collected specimens of a similar Brandschiefer or bituminous shale at different places in the Sierra of Mendoza, as near Challao,[1] at the Agua salada, west of the town, at the Cerro de Cacheuta, south of the same, and at the Agua de la Zorra in the Sierra de Uspallate. These shales are full of the same *Estheria*." The specimens illustrated by Dr. Geinitz, if regarded as showing their true shape, would represent more than one species, very difficult to identify with any known forms. They all seem, however, to have been more or less distorted by pressure, and to this cause, rather than to natural proportions, it appears likely that the diverse positions of the umbo, in relation to the antero-dorsal corner of the test, and the modifications of the concentric ridges, and the differences in the outlines, may possibly be due.

On careful consideration, it is evident that his fig. 4 is, of all the series, the most like *E. Mangaliensis*, Jones, and that figs. 1 and 2 may belong to the same species, but have been obliquely narrowed by pressure. Of the other three, fig. 5 is most like *E. Forbesii*, Jones, as to outline and number of ridges, but has been narrowed vertically by pressure. Figs. 3 and 6 differ from the others, and from each other, by the position of the umbo, number of ridges, and general shape. In explanation of the above remarks, the following notes are given :—

§ III. (1) Estheria Mangaliensis, Jones.

Estheria Mangaliensis, Jones, "Monogr. Foss. *Estheriæ*": Pal. Soc. 1862, p. 78, pl. ii, figs. 16–23.

——— ——— Geinitz (*pars*), Palæontographica, Suppl., iii, Palæont. Theil ii, Abth. 2; Beiträge, etc., 1876, p. 3, pl. i, fig. 4 and figs. 1 and 2?

——— ——— Middleton, Intellect. Observer, No. xxi, October, 1862, p. 317.

——— ——— Medlicott and Blanford, "Manual Geol. India," 1879, p. 130, woodcut; 2nd edit., 1893, p. 170, woodcut.

[1] In his "Reise durch die La Plata Staaten," etc., 2 vols., 1861, at page 277 of vol. i, H. Burmeister observed at some places "remnants of Cypridinen-Schalen, with the little Crustaceans characteristic of the Coal-formation of Europe." In his "Description physique de la République Argentine," 5 vols., 1876–8, in vol. i (1876), p. 262, Burmeister states that "on the eastern side of the mountains, towards the plain of the Pampa, is a small ravine opening out above the Bath of Challao; and in it are some black, irregularly flaking shales, like the Coal-shales; and these contain here and there traces of carbonized leaves, and on other surfaces impressions of little shells, like the valves of *Cypridina*, that remarkable Crustacean genus, belonging to the Phyllopoda, near the genus *Estheria*, and so characteristic of the Coal-beds of Europe." Burmeister here evidently alluded to the "Cypridinen-Schiefer" (*Entomis*-shales) characteristic of the Devonian (not the Carboniferous) of Europe from Russia to England.

Adult carapace-valves, broadly subovate in outline. Length 8·3, height 5·6 mm. Young forms, subtriangular or suboblong. Its resemblance to *E. Gihoni* is mentioned at p. 78, op. cit.

The original was from Mangali in Central India, probably of Rhætic age. Dr. Geinitz's specimens (see above) were from Challao and elsewhere[1] in the Mendoza province of the Argentine Republic; accompanied by *E. Forbesii* if we take Geinitz's fig. 5, pl. i (1876), to represent the latter species. Of the six figures referred by Dr. H. B. Geinitz to *E. Mangaliensis* (op. cit. 1876), one, namely fig. 4, seems to represent this species, and figs. 1 and 2 may also belong to it.

	Concentric Ridges.	Meshes from Ridge to Ridge.
E. Dahalacensis	14–15 . . .	6–7
E. Gihoni	14–15 . . .	6–7 adult, but not so old as the others.
E. Mangaliensis	16–17 . . .	7–8
E. Forbesii	22–23 . . .	17–18

E. Forbesii (numbers imbedded in a brownish shale) was brought to England by David Forbes in 1861 from Cacheuta, in the province of Mendoza.

Professor Philippi's specimens of *E. Mendocina*, referred to further on, also came from near Cacheuta in Mendoza. It bears a close resemblance to *E. Forbesii*, and measures 11 × 8 mm.

§ IV. Stelzner; Cacheuta, 1885.

The Cerro de Cacheuta, on the eastern slope of the Andes, 3500–4000 feet above the sea, is about twenty miles S. by W. of Mendoza city (33° S. lat.), in the Argentine Republic. Its geological structure is shown in Stelzner's map and sections (pl. iii) in his "Beiträge zur Geologie und Palaeontologie des Argentinischen Republik," I, Geologischer Theil, 1885, p. 76, etc.; in Fischer's "Palæontographica," Suppl., iii, Lieferung ii, Heft 1, "Ueber die geognostischen Verhaltnisse der Umgegend von Mendoza," etc.

This hill of Cacheuta consists mainly of gneiss and mica-schist, with a central mass of intrusive igneous rocks ("trachyte, andesite, and basalt"). On one flank of the hill strata of variegated sandstone, with clay and carbonaceous shale, lie in a broken syncline with steep sides. These beds are referred to the Rhætic series.

§ V. Philippi, 1887.

In his "Die Tertiären und Quatären Versteinerungen Chiles," etc., 1887, Dr. R. A. Philippi described and gave some small figures of two kinds of *Estheria*, p. 223, pl. L, figs. 11 and 12. The little outline, fig. 11 (16 × 12½ mm.) is described as a suborbicular form, like "*Estheria Dahalacensis*" (probably by accident or error), slightly oblique, very thin, almost flat, with irregularly concentric wrinkles; one margin nearly straight, with the umbo at two-fifths of its length. Philippi named it *Estheria? Chilensis* (reproduced

[1] Of the six specimens it is stated, at p. 16, that they came from Agua de la Zorra, Challao, Agua salada, Cerro de Cacheuta, and San Lorenzo.

in Pl. X, Fig. 5) ; and stated that it came *probably* from the district of Lebu. This is on the sea-coast in the province Arauca, Chili, 37° 36′ (or 37° 39′) S. lat., and is said to be on a Tertiary formation, in which are seams of lignite or coal, associated with shales bearing Tertiary marine shells. Stelzner intimates that Philippi's researches (1878 and 1883) prove the existence there of both an Eocene and a later Tertiary formation. See also Philippi, "Tert. u. Quat. Verst. Chiles," 1887, p. 17.

The little sketches in fig. 12 (11 × 8 mm.) have in their general aspect the look of *E. Forbesii*, being subovate, with a long, straight back ; and, although the curvatures of the ends do not correspond (possibly having been squeezed), the specimens shown by fig. 12 (reproduced in Pl. XI, Fig. 2) may safely be referred to the above-mentioned species. Philippi mentions that they came from Cacheuta in Mendoza, and named them *E.? Mendocina*. Unfortunately, he stated that they are like a "*Posidonia*." Most probably by some accident "*Posidonia*" and "*E. Dahalacensis*" were erroneously misplaced one for the other by the author in writing his notes on these two species.

To make the subject quite clear the following notes are necessary :

§ VI. (2) Estheria Forbesii, Jones.

PLATE XI, Fig. 2.

Cypridina, Burmeister, 1861, "Reise durch die La Plata Staaten," vol. i, p. 77 ; "Descrip. Phys.," etc., vol. i, 1876, p. 262.

Estheria Forbesii, Jones, "Monogr. Foss. *Estheriæ*" : Pal. Soc. 1862, p. 109, pl. iv, figs. 8-11.

E. Mendocina,[1] Philippi, "Tert. u. Quat. Verst. Chiles," etc., 1887, p. 223, pl. L, fig. 12.

E. Megalensis (*pars*), Geinitz, "Beiträge zur Geologie und Palaeontologie des Argentinischen Republik," II, Palaeont. Theil, Abth. 2; "Ueber Rhaetische Pflanzen- und Thier-Reste in den Argentinischen Provinzen La Rioja, San Juan, und Mendoza," 1876, p. 3, pl. i, fig. 5.

This straight-backed *Estheria* is suboblong when adult ("Monogr. Foss. *Esth.*," pl. iv, fig. 8), with about twenty-two concentric ridges ; their interspaces reticulate, with about seventeen meshes from ridge to ridge. In the young state (fig. 9, with 13 ridges ; and fig. 10, with only seven) the shape is subcircular or subquadrate, as in other young *Estheriæ*. The adult form (fig. 8) measures—length 11·2, height 7 mm.

E. Forbesii much resembles several other known *Estheriæ* in general shape and in style of ornament ; but there are points of difference in all these cases. Some varieties of the Triassic *E. minuta* may be alluded to : such as "Monogr.," pl. ii, fig. 9, var. *Brodieana* ;

[1] The province of Mendoza, indicated by the name *Mendocina*, formerly belonging to Chili, and so referred to by Philippi, was previously known as Cuyo, and part of La Plata. It is now described by geographers as belonging to the Argentine Republic, the mutual boundary having been settled by a treaty in 1881. The limit passes along the crest of the Andes down to the Magellan Straits.

also fig. 16, *E. Mangaliensis*; and *E. minuta* var. *latitexta*, Geol. Mag. 1890, Pl. XII, Fig. 8. These approach one another in outline and ornament, but appreciable differences are readily discernible.

Among recent species, *Estheria Dahalacensis*, Straus-Durckheim, and *E. Gihoni*, Baird, are also straight-backed forms, with reticulate ornaments between the ridges, but there are differences in outline and surface.

§ VII. (3) Estheria Aricensis, sp. nov.

PLATE X, Figs. 1–3.

This species is based on some specimens which the late David Forbes, F.R.S., brought to England, in 1861, from Arica in Southern Peru (now held by the Chilians), in 18° 25′ S. lat., 70° 15′ W. long. These fossils have been placed in the British Museum (Nat. Hist. Branch) since *Estheria Forbesii* was described by me in 1862. They are illustrated by Figs. 1–3, and are obliquely subcircular (not unlike some forms of *Posidonomya*), with the longest diameter at an angle of about 60° to the hinge-line. This latter is usually about half the length of the valve, but sometimes two-thirds. The umbo is in the anterior third of the cardinal margin, and rather prominent above the hinge-line.

The concentric ridges are numerous (16 or more), mostly large and coarse, but somewhat obscured by pressure and the granular sandy condition of the matrix. In one large hollow mould (unfortunately imperfect, Fig. 3), vertical barrolets, or small transverse ridgelets, are visible in the broader interspaces.

These specimens from Arica measure—

Fig. 2, length 9·4 mm., height 8·0 mm.
Fig. 1, length 13·63 mm., height 9·45 mm.
Fig. 3 (imperfect), length 17·0 mm., height 15·02 mm.

From a fractured internal cast of a valve, the thickness of the closed carapace of a large individual may have been about 4 mm.

They occur on the bed-planes of a hard, black, irregularly fissile, sandy shale, which has weathered brown inwards to some distance from the surface. According to David Forbes's label they came from "Bed F, Morro de Arica." The hill near the town rises to about 500 feet above the sea-level. He was there in 1857, and on May 27, 1861.

In the Quart. Journ. Geol. Soc., vol. xvii, 1861, pp. 35–6, he described the section as exhibiting a succession of interstratified shales and porphyries, to which, although regarded as Carboniferous by D'Orbigny, D. Forbes hesitated to assign any definite age, for want of evidence.

These *Estheriæ* from Arica differ from Philippi's *E. Chilensis*[1] by the greater obliquity of the valves and more definite hinge-line. Philippi's published sketch, op. cit., 1887, pl. L, fig. 11, gives, however, poor data for a decision. (See Pl. X, Figs. 4 and 5.)

[1] 1887; see above, p. 262.

The obliquity of these suborbicular valves (about 60°) approximates to that of *Cyclestheria*, as defined by G. O. Sars[1]; but the latter is much more nearly circular in outline (Fig. 6).

The more protuberant umbo, further from the anterior corner, and the more distinctly level straightness of the hinge-line behind it, are distinctive characteristics, as well as the somewhat more prolate antero-dorsal region of the valve in front of the umbo.

(*To be concluded in our next Number.*)

NOTICES OF MEMOIRS.

I.—On the Distribution of Marine Mammals.[2] By P. L. Sclater, M.A., Ph.D., F.R.S., Sec. Zool. Soc.

(Read before the Zoological Society, March 16, 1897.

I. *Introductory Remarks.*—Most of the recent writers on Geographical Distribution have confined their attention to terrestrial mammals, or at any rate have but casually alluded to the marine groups of that class. On the present occasion I wish to call your attention to some of the principal facts connected with the distribution over the world's surface of the marine or aquatic members of the Class of Mammals.

Aquatic mammals, which pass their lives entirely, or, for the greater part, in the water, are, of course, subject to very different laws of distribution from those of the terrestrial forms. As regards aquatic mammals, land is of course an impassable barrier to their extension, and, subject to restrictions in certain cases, water offers them a free passage. Just the opposite is the case with the terrestrial mammals, to which in most cases land offers a free passage, while seas and rivers restrain the extension of their ranges.

The groups of aquatic mammals that are represented on the earth's surface at the present time are three in number, viz.: (1) the suborder of the Carnivora, containing the Seals and their allies, generally called the Pinnipedia, which are semi-aquatic; (2) the Sirenia, which are mainly aquatic; and (3) the Cetacea, which never leave the water, and are wholly aquatic. We will consider briefly the principal representatives of these three groups, following nearly the arrangement of them employed in Flower and Lydekker's "Mammals, living and extinct."

[1] Christiania Vidensk.-Selsk. Forhandl. 1887, No. 1, pl. i, figs. 1–3. Dr. Baird gave a rather more symmetrical form to this subcircular species (Proc. Zool. Soc. 1859, p. 232; and 1860, p. 188, pl. lxiii, fig. 1), triangular on the dorsal and rounded on the ventral margin. His figure, if placed with the hinge-line horizontal, shows a subcentral umbo, with the hinge-line almost level behind it, and equal to half of the transverse diameter of the valve. There is a rapid slope in front, meeting the anterior part of the more than semicircular free margin.

[2] For the Land-Provinces proposed by the author for the Geographical Distribution of Birds, see Dr. P. L. Sclater's paper in Journ. Proc. Linn. Soc. (Zoology) 1858, vol. ii, pp. 130–45; also Rep. Brit. Assoc. 1860, Trans. Sec., pp. 121, 122; H. Woodward, Geol. Mag. 1885, Decade III, Vol. II, p. 315, and Proc. Geol. Assoc. 1886, vol. ix, No. 5, p. 366.

II. *Distribution of Pinnipeds.*—The Pinnipeds, which I will take first, comprise three distinct families—the Otariidæ, the Trichechidæ, and the Phocidæ. Beginning with the Otariidæ or Eared Seals, commonly known as Sea-lions and Sea-bears, we find the greater number of the species confined to the South Polar Ocean, where they pass most of their time at sea, but, as is well known, resort to the land at certain seasons for breeding purposes. In the Atlantic Ocean, so far as I know, the Eared Seals have never been ascertained to occur further north than the estuary of the La Plata on the American coast, and the vicinity of the Cape on the African coast. But in the Pacific, on the contrary, three distinct species of *Otaria* are found all over the Arctic portion of that ocean, and there are well-founded traditions of Eared Seals having been formerly met with in the Galapagos, while they still occur on the coast of Peru and Chili. I think, therefore, we may assume that *Otaria* was originally an Antarctic form, but has travelled northwards along the West American coast and is now firmly established in the North Pacific. In a parallel way in the class of birds, the Albatrosses (*Diomedea*), which are essentially a group of the Antarctic seas, are represented by three distinct species in the North Pacific.

The second family of the marine Carnivora, on the other hand, the Walruses (Trichechidæ), are entirely Arctic in their distribution; one species (*Trichechus rosmarus*) being peculiar to the North Atlantic, while a second nearly allied species (*T. obesus*) takes its place in the Northern Pacific.

The third family of Pinnipeds is more numerous and varied, both in genera and species, than the two preceding, and has a more extended range. The Seals (Phocidæ), embracing about nine different generic forms, are most numerous in the Arctic and Antarctic seas, but are also feebly represented in some intermediate localities. Beginning with the North Atlantic, we find several species of *Phoca* inhabiting various parts of this area, and the Grey Seal (*Halichœrus*) and the Bladder-Seal (*Cystophora*) exclusively confined to it. In the North Pacific all the four true Seals belong to the genus *Phoca*, and three of them are identical with the North Atlantic species, but when we descend as far south as the Gulf of California on the American coast we meet with a species of Sea-elephant (*Macrorhinus*) which, like *Otaria*, has no doubt penetrated up here thus far from its ancestral abode in the Antarctic Ocean.

Returning to the Central Atlantic, we find two species of Seals inhabiting these waters, both belonging to the same genus *Monachus*. One of these (*M. albiventer*) inhabits the Mediterranean and the adjoining coasts of the Atlantic, while the other (*M. tropicalis*) is in these days restricted to some of the smaller and less known islands of the West Indies.

The Phocidæ of the Antarctic Ocean all belong to genera distinct from the Arctic forms and more nearly allied to *Monachus*, the Seal of the Mid-Atlantic. They are of four species belonging to as many genera: *Ogmorhinus*, *Lobodon*, *Leptonychotes*, and *Ommatophoca*. Besides these the Sea-elephant of the whalers (*Macrorhinus*) is

essentially an Antarctic form, though now nearly extinct there, after long persecution by man. But, as already noted, it extends, or has in former days extended, far up the West coast of America, and is still occasionally found on Santa Barbara Island on the coast of California.

III. *Distribution of Sirenians.*—Only two forms of Sirenians are at the present time existing on the earth's surface—the Manatee (*Manatus*) and Dugong (*Halicore*) — each representing a distinct family of the order. The Manatee is an inhabitant of the coasts and estuaries of both sides of the middle Atlantic Ocean — one species (*Manatus Senegalensis*) occurring on the African shores, and another (*M. Americanus*) on the South American coast and in the Antilles. A third species (*M. inunguis*), so far as we know at present, is found only in fresh water high up the Amazons.

The Dugong (*Halicore*) is distributed from East Africa, along the shores of the Indian Ocean and its islands, to North Australia. Three species of this genus have been established — *Halicore tabernaculi* from the Red Sea, *H. dugong* from the Indian Ocean, and *H. Australis* from Australia; but it is doubtful how far these forms are actually distinguishable.

Beside *Manatus* and *Halicore*, a third quite distinct form of Sirenian was formerly an inhabitant of the North Pacific. This was Steller's Sea-cow (*Rhytina Stelleri*), by far the largest animal of the group, which was exterminated by human agency about 1768. Fortunately recent researches in Behring's Island have been successful in supplying specimens of its skeleton for our principal Museums, and Steller, its discoverer, left to posterity a good account of its habits and anatomy.

IV. *Distribution of Cetaceans.*—Adopting the recognized division of the Cetaceans into two suborders, Mystacoceti and Odontoceti, according as to whether their mouths are furnished with baleen ("whalebone") or teeth, we will first consider the True or Whalebone Whales, which consist of a single family, Balænidæ, usually divided into five genera: *Balæna*, *Neobalæna*, *Rhachianectes*, *Megaptera*, and *Balænoptera*. Of these, *Balæna*, *Megaptera*, and *Balænoptera* are almost cosmopolitan—species of them, whether distinct or not is at present more or less uncertain, being met with in nearly every part of the ocean. But *Rhachianectes* has as yet been ascertained to occur only in the Northern Pacific, and *Neobalæna* in the South Polar Ocean, so that we have in these cases two well-marked local types to deal with.

The Toothed Wales (Odontoceti) are more diversified than the preceding group, and are usually held to embrace at least four existing families besides several extinct forms. The first family, containing the Physeteridæ or Sperm-Whales, consists of at least six genera (*Physeter*, *Cogia*, *Hyperoodon*, *Ziphius*, *Mesoplodon*, and *Berardius*). *Physeter* and *Cogia* are inhabitants of the whole oceanic area between the tropics, extending in certain localities some way beyond them. *Hyperoodon* is confined to the North Atlantic. *Ziphius* has an extensive range, and has been found in nearly every

part of the ocean. *Mesoplodon* is also widely distributed, but is apparently more abundant in the Southern Hemisphere. *Berardius*, however, so far as we know at present, is restricted to the South Polar Ocean.

The third family of Toothed Whales contains only the Platanistidæ, or Fresh-water Dolphins, which, although, in some cases, at the present day entirely fluviatile, must probably have descended from oceanic forms. The three known genera are *Platanista* of the Ganges and Indus, *Inia* of the river Amazons, and *Pontoporia* of the river La Plata; the last form making a connecting link between the two preceding genera and the marine Dolphins.

The fourth family of Toothed Whales, containing the Dolphins, Delphinidæ, is very numerous in species and embraces at least fifteen or sixteen genera. But in spite of the efforts of Mr. True, who has recently given us an excellent summary of our present knowledge of them,[1] both the genera and species of Delphinidæ are still so imperfectly understood that I cannot say much about their geographical distribution. Most of the forms appear to be very widely distributed, but it may be said generally that Dolphins are most abundant in the intertropical seas and less plentiful both to the north and south of them.

There are, however, two forms that are exclusively inhabitants of the North Atlantic. These are the very remarkable Narwhal (*Monodon*), in which the male is furnished with a single enormous horn-like tusk, and the Beluga or White-Whale (*Delphinapterus*), closely allied to the Narwhal in many points of its general structure. These may be looked upon as quite isolated forms characteristic of the Arctic portion of the Atlantic, but not known in the Pacific.

V. *Division of the Marine Area of the Globe into Sea-regions.*—From what has been already said, it will be evident that, although many of the marine mammals have a wide distribution, others are very definitely localized; and a study of the latter will, I think, enable us to divide the oceanic portion of the globe into six Sea-regions, corresponding to a certain extent with the six Land-regions[2] into which I proposed to separate the terrestrial portion of the globe in 1874, and which were subsequently adopted by Mr. Wallace in his standard work on the Geographical Distribution of Animals. I propose to call these Sea-regions—

(1) The North Atlantic Sea-region or Arctatlantis (*ἄρκτος* and *Ἀτλαντίς*=the daughter of Atlas), consisting of the northern portion of the Atlantic down to about 40° N. lat.

(2) The Mid-Atlantic Sea-region or Mesatlantis (*μέσος* and *Ἀτλαντίς*), consisting of the middle portion of the Atlantic down to about the Tropic of Capricorn.

[1] See "A Review of the family Delphinidæ," by Frederick W. True: Bull. U.S. Nat. Mus., No. 36, Washington, U.S., 1889.

[2] Presidential Address, Sect. Biology, Brit. Assoc. 1875 (Bristol); and Proc. Roy. Inst., vol. viii, pp. 511–13 (1878).

(3) The Indian Sea-region or Indopelagia (Ἰνδός and πέλαγος), containing the Indian Ocean down to about the same degree of S. lat., and extending from the coast of Africa on the west to Australia and the great Oriental islands on the east.

(4) The North Pacific Sea-region or Arctirenia (ἄρκτος and εἰρήνη =*pax*), containing the northern portion of the Pacific Ocean down to about the Tropic of Cancer.

(5) The Mid-Pacific Sea-region or Mesirenia (μέσος and εἰρήνη), containing the intertropical portion of the Pacific Ocean; and finally,

(6) The Southern Sea-region or Notopelagia (νότος and πέλαγος), containing the whole of the South Polar Ocean all round the globe south of the above-mentioned limits.

We will now proceed to consider shortly the characteristic Mammals of these six Sea-regions.

VI. *The North Atlantic Sea-region, or Arctatlantis.*—Amongst the Pinnipeds two well-marked generic forms, the Grey Seal (*Halichœrus*) and the Bladder-Seal (*Cystophora*), are exclusively confined to Arctatlantis. The True Seals (*Phoca*) and the Walrus (*Trichechus*) are found in this region and in Arctirenia; and of the former genus three species (*P. vitulina*, *P. Grœnlandica*, and *P. barbata*) are actually common to both these Sea-regions, while the Walruses (*Trichechus rosmarus* and *T. obesus*) of the two Sea-regions are perhaps somewhat doubtfully distinguishable. It may be easily understood how this has come to pass, because the Seals and Walrus may in the course of time, during unusually mild summers, have extended themselves along the north coast of the American continent into the Northern Pacific. But Arctirenia, as we shall presently show, is markedly distinguishable from Arctatlantis by the presence of Eared Seals (*Otaria*), which are utterly unknown in the whole of the Atlantic area. *Otaria* is, in fact, as regards Arctatlantis what I have called on previous occasions (see P.Z.S. 1882, p. 311) a "lipotype" of Arctatlantis, but what I now propose to designate a "lipomorph."[1]

The Sirenians are entirely absent from the North Atlantic and constitute another lipomorph of that area.

Coming to the Whales, we find the Mystacoceti well represented in the North Atlantic by *Balæna*, *Megaptera*, and *Balænoptera*, but of these the two latter are almost universally distributed over the ocean, and *Balæna* recurs again in the North Pacific as well as in more southern latitudes, so that there is no genus of Whalebone Whales peculiar to Arctatlantis, although the great *Balæna mysticetus* has never been found elsewhere.

Proceeding to the Odontoceti, the case is different. Amongst the

[1] On former occasions I have used the term "lipotype" for a natural group which characterizes a particular locality by its *absence*. It would, however, perhaps be better to change the term to "lipomorph," because the type and its compounds have been generally employed in reference to the particular specimens of a species upon which original descriptions are based (cf. Thomas, P.Z.S. 1893, p. 241). In the same way a natural group which characterizes a particular country may be called a "topomorph" (τόπος, *locus*, and μορφή, *forma*). Thus in Africa *Giraffa* and *Phacochœrus* would be "topomorphs," and *Cervus* and *Ursus* would be "lipomorphs."

Physeteridæ, *Hyperoodon* is confined to Arctatlantis, and, as already explained, two very well-marked types of the Delphinidæ, *Delphinapterus* and *Monodon*, are likewise exclusively denizens of the North Atlantic ocean. Arctatlantis, therefore, may be said to be well characterized by the possession of at least five genera of Marine Mammals not found elsewhere, viz. *Halichœrus*, *Cystophora*, *Hyperoodon*, *Delphinapterus*, and *Monodon*.

VII. *The Middle Atlantic Sea-region, or Mesatlantis.*—Mesatlantis has certainly not so many forms of Marine Mammals confined to its area as Arctatlantis, but there seem to be good grounds for its separation. As we descend towards the tropics the true Seals (Phocinæ), which are constituted to live in colder water, gradually fall off in number, and in Mesatlantis are no longer met with. But in their place we find the genus *Monachus* or Monk-Seal restricted to Mesatlantis, one species (*M. albiventer*) occurring in the Mediterranean and on the North African coast, and a second (*M. tropicalis*) being found in the West Indies. Mesatlantis is likewise the true home of the well-marked Sirenian genus *Manatus*, one species of which (*M. Americanus*) frequents the coast of America and another (*M. Senegalensis*) that of Africa.

As regards the Cetaceans we are not able to say that Mesatlantis, although well furnished with many generic types of this Order, has anyone peculiar to it. We must therefore rest content with assigning two genera of Marine Mammals, *Monachus* and *Manatus*, as characteristic forms or topomorphs of the Sea-Mammal life of Mesatlantis.

VIII. *The Indian Sea-region, or Indopelagia.* — The Marine Carnivora, so far as we know, are entirely foreign to Indopelagia, but the Sirenians are well represented by the Dugong (*Halicore*), which pervades all its northern coasts from North Australia to India and the Red Sea and down the African coast to Lamu.[1] Whether the species of *Halicore* found at different points within this area are the same or different, is still a matter of discussion, but there can be no doubt that *Halicore* is an exclusive inhabitant of Indopelagia. As regards the Whales of Indopelagia, we know that *Physeter*, *Cogia*, and *Ziphius*, and numerous forms of Delphinidæ occur there. but I am not aware of any Cetacean that is entirely restricted to this Sea-region.

IX. *The North Pacific Sea-region, or Arctirenia.*—As was pointed out when speaking of Arctatlantis, Arctirenia has one genus of Phocidæ (*Phoca*) in common with the North Atlantic, and three of the species of this genus appear to be actually identical in these two Sea-regions, whilst a fourth *Phoca* (*P. fasciata*) is only found in the North Pacific. The Walrus (*Trichechus*) is again a form of Marine Mammals common to both the great northern Sea-regions. But the feature of Pinnipedian life that absolutely distinguishes Arctirenia from Arctatlantis is the presence in the former of three (if not four) well-marked species of the Eared Seals (Otariidæ), which are absolutely unknown in the vast extent of the Atlantic down at least to 30° S. lat.

[1] A fine specimen of the Dugong from Lamu (on the east coast of Africa, lat. 2° 50′ S.), obtained by Mr. J. C. Haggard in 1885, is in the British Museum.

Arctirenia has unfortunately lost its Sirenian, Steller's Sea-cow (*Rhytina Stelleri*), the largest and finest modern representative of this formerly prevalent group, which since the days of the Pleistocene has greatly diminished in numbers, but I think we may still treat *Rhytina* as one of the characteristic forms of the Arctirenian Sea-region. The North Pacific is also even at the present day the sole possessor of a remarkable genus of Whalebone Whales which combines the long head and elongate form of *Balænoptera* with the smooth skin of the throat and absence of the dorsal fin of *Balæna*.[1] This is the Grey Whale, *Rhachianectes glaucus* of Cope, which, in these days, is confined to the North Pacific, and does not range farther south that the 20th parallel in that ocean. At the same time it should be stated that indications have been discovered that a nearly allied form existed in the Atlantic in previous geological ages, though this is by no means certain. Besides *Rhachianectes*, *Balæna*, *Megaptera*, and *Balænoptera* are all represented in the North Pacific, and also many species of Delphinidæ, of which little is at present known. But *Rhytina* and *Rhachianectes* are the only genera of Marine Mammals absolutely confined to Arctirenia.

X. *The Middle Pacific Sea-region, or Mesirenia.*—The Eared Seals, *Otaria*, must have necessarily passed through Mesirenia in their passage from south to north, though the only record of their recent presence in the central part of the Pacific is, so far as I know, the report that they were formerly found in the Galapagos. It should be stated, however, that Tschudi records the occurrence of two species of *Otaria* on the islands of the coast of Peru, and that in 1802 Humboldt met with an Eared Seal on the Island of San Lorenzo, in the Bay of Callao, which is only some 12° south of the Equator.

Like *Otaria*, the Sea-elephant (*Macrorhinus*) has apparently in former ages travelled up the South American shores and established itself as far north on the coast of California at about 34° N. lat. The Californian Sea-elephant has been discriminated by Gill as a distinct species (*Macrorhinus angustirostris*), but its differences from the southern form (*M. leoninus*) seem to be but trifling.

As regards the Cetaceans of Mesirenia, our information is at present very imperfect, and I have little to say except that species of *Megaptera*, *Balænoptera*, *Physeter*, *Cogia*, and *Ziphius* certainly occur there, besides many representatives of the widely-spread Delphinidæ.

XI. *The Southern Polar Sea-region, or Notopelagia.*—The wide ocean which surrounds the Southern Pole on every side, and extends up to 40° S. lat., seems to present, as regards its marine mammals, a nearly homogeneous fauna, which we will now briefly consider. In the first place it contains representatives of four genera of true Phocidæ—*Ogmorhinus*, *Lobodon*, *Leptonychotes*,[2] and *Ommatophoca*,

[1] Flower and Lydekker, "Mammals," p. 241.

[2] This generic term, established by Gill in 1872, seems to take precedence of *Pœcilophoca*, proposed by Flower and Lydekker for the same type (*L. Weddelli*) in 1891. Cf. Allen, "North American Pinnipeds," p. 418.

which are peculiar to the southern seas, and are quite distinct from all their northern representatives in the Arctic Ocean. The Sea-elephant, *Macrorhinus*, is also a denizen of Notopelagia, though, as we have already seen, it has wandered north along the South American coast far into Mesirenia.

Like *Macrorhinus*, *Otaria* also, containing the group of Eared Seals, appears to have been originally an Antarctic group, and the greater number of its species, although nowadays very much reduced in numbers, are still found in the Southern Ocean. But the *Otariæ* have travelled still further north than *Macrorhinus*, and three, if not four, species, as already stated, are in these days well-established inhabitants of Arctirenia.

The Sirenians are absent from Notopelagia, but Cetaceans of every kind are abundant. Besides one or more representatives of the true Whalebone Whale (*Balæna*), Notopelagia has a smaller representative of the group (*Neobalæna*) entirely restricted to its area. It has also representatives of *Megaptera* and *Balænoptera*, though it is doubtful how far they are even specifically distinct from some of their northern representatives.

Among the Toothed Whales (Odontoceti) we find a large Ziphioid form, *Berardius*, restricted to the Notopelagian area, while *Ziphius* and *Mesoplodon* also occur there. The Dolphins (Delphinidæ) are likewise numerous, and present some distinct species, but not, so far as our present knowledge extends, any generic forms that do not occur elsewhere.

But Notopelagia is sufficiently distinguished from all the five more northern sea-regions by possessing four genera of Seals and two of Cetaceans entirely restricted to its area.

XII. *Conclusions.*—It has therefore, I think, been shown that for the Geography of Marine Mammals, the Ocean may be most conveniently divided into six Sea-regions, as follows:—

I. Regio Arctatlantica, characterized by its Seals (Phocinæ), of which two genera, *Halichœrus* and *Cystophora*, are peculiar, whilst *Phoca* is common to it and Arctirenia; by the absence of Sirenians; and by the possession of three peculiar genera of Cetaceans (*Hyperoodon*, *Delphinapterus*, and *Monodon*).

II. Regio Mesatlantica, sole possessor of the Monk-seal, *Monachus*, amongst the Pinnipeds, and of the Sirenian genus *Manatus*.

III. Regio Indopelagica, characterized by the presence of the Sirenian *Halicore* and by the absence of Pinnipeds.

IV. Regio Arctirenica, with *Phoca* like the Regio Arctatlantica, but having *Otaria* also; the home of the (now extinct) Sirenian *Rhytina* and of the endemic Cetacean *Rhachianectes*.

V. Regio Mesirenica, without true Seals (Phocinæ), but having *Otariæ* and *Macrorhinus* from the South; no Sirenian known.

VI. Regio Notopelagica, characterized by four endemic genera of Phocidæ, and by the presence of many *Otariæ*; without Sirenians, but with two endemic forms of Cetaceans (*Neobalæna* and *Berardius*).

In conclusion, I will call attention to some of the more remarkable

points in the general distribution of the marine Mammals, and to their apparent significance.

In the first place, it is evident that the Pacific has much more in common with the Notopelagian region than the Atlantic. *Otaria* and *Macrorhinus*, quite unknown in the Atlantic, extend themselves to the northern extremity of the Pacific, the former pervading that ocean up to Behring's Straits, and the latter reaching to the Californian coast. It follows that in former ages there must have been some barrier in the Atlantic which did not exist in the Pacific to stop their progress northwards. The only barrier I can imagine that would have effected this must have been a land uniting South America and Africa, across which they could not travel. Adopting this hypothesis, we have at the same time an explanation of the presence of the Manatee on both the American and African coasts. The Manatee could hardly live to cross the Atlantic. It is only found close to the coast, where it browses on seaweeds and other vegetable food in shallow water. How did it travel from America to Africa (or *vice versa*), unless there were a continuous shore-line between them? The same may be said of the Monk-seal (*Monachus*), of which one species lives in the Mediterranean and on the African coast and islands, and another in the West Indies. We can hardly believe that these creatures could easily traverse the whole Atlantic.

Topomorphs of the Sea-regions.

I. Arctatlantis.

Halichœrus.
Cystophora.

Hyperoodon.
Delphinapterus.
Monodon.

II. Mesatlantis.

Monachus.

Manatus.

Inia.
Pontoporia.

III. Indopelagia.

Halicore.

Plantanista.

IV. Arctirenia.

Otaria.

Rhytina (extinct).
Rhachianectes.

V. Mesirenia.

Otaria.
Macrorhinus.

VI. Notopelagia.

Ogmorhinus.
Lobodon.
Leptonychotes.
Ommatophoca.
Otaria.

Neobalæna.
Berardius.

The hypothesis of a former barrier of land between Africa and America, which we know is supported by other facts of distribution,[1] would alone explain the difficulty.

On the other hand, in the Pacific we find no such break between the north and south. The aquatic Mammals of Notopelagia have evidently had free access to the whole of the Pacific for a long period, and have well availed themselves of this facility.

Again, while the great Southern Ocean exhibits a considerable uniformity of marine mammalian life, we see the Northern waters divided into two distinctly recognizable regions by the interposed masses of land. All these facts, with the one exception of the supposed Atlantic barrier, would tend in favour of the now generally accepted doctrine that the principal masses of land and water are not of modern origin, but have existed mainly in their present shapes throughout all ages.

II.—Reconhecimento Geologico dos Territorios Portuguezes, comprehendidos entre Lourenço Marques e o Rio Zambeze. Por Alfredo A. Freire de Andrade. Dissertação para o concurso da 7ª Cadeira da Escola Polytechnica. (Lisboa: Imprensa Nacional, 1894.)

A Geological Reconnaissance of the Portuguese Territories between Lorenzo Marques and the Zambesi River. By A. A. Freire de Andrade. Competitive dissertation for the seventh Chair in the Polytechnic School. 8vo; pp. 184, with a geological sketch-map. (Lisbon, 1894.)

THIS memoir contains an instructive description of the main geographical and geological features of that part of the Portuguese Province of Mozambique which lies south of the Zambesi River. Apart from its natural features, the region is of considerable interest at the present time, from its position between the Transvaal and the British South African Company's Territories on the one hand, and the sea on the other. In most English maps the country is divided into the districts of Gaza, Sofala, Manica, Sena, and Tete, but only three divisions are given in this paper, namely, the districts of Lorenzo Marques and of Inhambane on the south, and the Territories of the Mozambique and Zambesi Companies on the north. The Lorenzo Marques district consists almost exclusively of low, flat, or slightly undulating areas, bounded on the west by the porphyritic mountains of the Limbombos range, which run northwards from the Natal boundary. The range is traversed by numerous rivers, the most important being the Incomati, the Elephant, and the Limpopo. The Inhambane district is likewise a nearly flat, sandy plain of an average elevation of 300 mètres, which extends between the Limpopo and the Save River. Near the coast, the level of the country abruptly falls towards the sea. Many of the rivers and the lagoons of this district are largely charged with saline materials.

[1] Cf. Wallace, "Geogr. Distrib.," vol. i, p. 156.

North of the Save River, in the Mozambique and Zambesi Companies' territories, the aspect of the country entirely changes; instead of sandy plains there is a succession of undulations of gradually increasing elevation, which beyond the Morungueze reach to the summit of the plateau, at levels of 1000 to 1200 m. Beyond the Lusiti River, running from south to north, is the wall-like range of the Chimanimani Mountains, the summits of which are 2000 m. above the sea. The principal rivers of this northern district are the Zambesi, Pungue, Revue, Lusiti, Busi, Mossurize, and the Save. A large portion of this area consists of gneiss and granite, which extend to near the coast and then disappear beneath modern alluvium. The author distinguishes (1) granitoid gneiss passing into granite, (2) gneiss with intercalated beds of pyroxene and with garnets and amphibolites, and (3) mica schists and chloritic schists.

In the country between Lorenzo Marques and the Zambesi there is a close connection between the altitude and the geological structure, so that it is possible to divide it into three principal zones. The lowest or coast zone, reaching from sea-level to 300 m., consists for the most part of Tertiary sediments, modern alluvial deposits, and sand-dunes. A large part of the southern districts of Lorenzo Marques (except the Limbombos Mountains) and Inhambane, and a small part of the Companies' territories, are included in this zone. The second or middle zone, from 300 to 600 m., includes the Limbombos and a large part of the northern territory, and the predominant rocks are gneiss and the more recent crystalline rocks, such as porphyry, porphyrites, and melaphyres. The third or high zone includes the eastern slopes of the high plateau and adjacent areas, with elevations between 600 and 2400 m. The rocks of this zone are principally schists, with a great variety of ancient crystallines, such as granites, granulites, diorites, diabases, gabbros, etc.

The gneiss areas are first seen in the latitude of the Mossurize River, and from here they continue northwards without interruption, forming nearly the whole of the hydrographic basin of the Busi River, except in one or two restricted localities where they are covered by Palæozoic sedimentary strata, which are traversed by granites and other eruptive rocks.

The more ancient sedimentary rocks of the country resemble those of other adjacent parts of South Africa in the absence of fossils; and as a consequence considerable doubt exists regarding their geological age. The author refers to the Silurian or Devonian a thick series of argillaceous and siliceous schists and quartzites, which are developed more particularly along the eastern declivity of the high plateau between the Save and the Zambesi, and in the Chimanimani Mountains exhibit a proximate thickness of 1000 m. They have been much disturbed and compressed, and in places they are traversed by diabases and granulites. No fossils have as yet been found in them, and their age is conjectured from their occurrence anterior to rocks considered to be Carboniferous.

Shales, sandstones, and grits, with beds of coal of Carboniferous age, occur along the left bank of the Zambesi, in the Tete basin, and in the area between it and the Rovugo river. The flora of these beds has been studied by Zeiller: it includes species of *Pecopteris*, *Allipteridium*, *Alethopteris*, *Annularia*, *Sphenophyllum*, *Cordaites*, and *Calamodendron*, which are considered to indicate the horizon of the Upper Carboniferous in Europe. Some of the bands of coal are of considerable thickness, but the quality is inferior, and owing to their distance from the coast they cannot be worked economically.

To the Karoo Formation the author attributes the conglomerates of Lorenzo Marques which extend along the east face of the Limbombos range nearly to the frontiers of the Transvaal. They consist mainly of stones and boulders of quartzite, and in places also rolled pebbles of amethyst, opal, etc., probably derived from beds of amygdaloidal porphyry. No fossils are known from these conglomerates, and all that can be positively said about them is that they are later than the Carboniferous and Pre-Jurassic, and contemporaneous with the eruptive period which continued from the Carboniferous to the Triassic.

The rocks which are found next above the Karoo series are limestones containing Nummulites, which occur near the base of the slopes of the Chimanimani Mountains, having a very slight easterly dip. They are hard, compact, white or yellow rocks, mainly composed of remains of Nummulites and other Foraminifera, with some moulds of Gasteropods. The Nummulites are small and flattened; two species, *N. Biarritzensis* and *N. Beaumonti*, can be recognized. These prove the Eocene age of the beds.

Of probably Miocene age are beds of marl overlain by compact white limestones, which occur near Goruja and the junction of the rivers Revue and Busi. The marls contain *Trochus patulus* (a Miocene species), *Ostræa crassissima*, and fragmentary shells of *Turritella* and *Cardita*.

It is not certain that Pliocene beds are represented south of the Zambesi, but the siliceous sands, which cover so large a portion of the districts of Lorenzo Marques and Inhambane, may be of this period. In some places they reach a thickness of 50 m. In some calcareous beds, which pass up into the sands, there have been found impressions of *Tapes*, *Cerithium*, and *Tellina* with a very characteristic Pliocene aspect, which supports the view that the sands may be Pliocene.

Of comparatively recent deposits may be noticed extensive areas of alluvium near the mouths of the large rivers, and the sand-dunes along the coast. The auriferous sands in the river beds within the Portuguese territory, which have been worked in many places, are too poor to yield a profit, and no other metalliferous deposits of any importance are known.

In the concluding chapter the author gives detailed descriptions of microscopic sections of the crystalline rocks from various localities.

G. J. H.

REVIEWS.

I.—The Diplograptidæ and Heteroprionidæ of the Scanian *Rastrites* Beds. By Sv. Leonk. Törnquist. Trans. Roy. Phys. Soc. Lund, New Ser., vol. viii, 1897.

THIS short monograph by Dr. Törnquist forms a welcome addition to our knowledge of the later Diplograptidæ. In his Introduction, he remarks that he has dealt only with well-preserved specimens, rightly laying stress on the confusion created by the indiscriminate determination of imperfect forms.

In the "*Rastrites* Beds" the author includes the equivalents of our Lower and Upper Birkhill Shales, and the lower beds of the Gala-Tarannon Group.

As regards the subdivision into zones, the classification is that adopted by Tullberg in his "Skånes Graptoliter," except where recent work has necessitated a slight modification.

The following life-zones have been detected:—

1. Zone of *Diplograptus acuminatus*, Nich. (at base).
2. Zone of *Monograptus cyphus*, Lapw.
3. Zone of *Monograptus triangulatus*, Harkn. (= Lower part of Scottish zone of *M. gregarius*, Lapw.)
4. Zone of *Diplograptus folium*, His. (= Tullberg's zone of *M. convolutus*, His.)
5. Zone of *Diplograptus cometa*, Gein.
6. Zone of *Monograptus Sedgwicki*, Portl.
7. Zone of *Monograptus runcinatus*, Lapw.

In dealing with the description of the species the author has found it advisable to introduce a few new terms. He uses the term *prolific side* for that side of the sicula which communicates with the proximal cavity of the rhabdosoma; while he designates the opposite side the *dorsal side*. The term *virgella* is suggested for the so-called proximal prolongation of the virgula, which Wiman has shown to be no part of the true virgula, but a special filiform rod-like organ originating on the prolific side of the sicula.

The following species are described:—

Diplograptidæ.

1. *Climacograptus scalaris*, His.
2. *Climacograptus medius*, sp. nov.
3. *Climacograptus rectangularis*, McCoy.

These three species cannot be distinguished when in a fragmentary condition. *C. scalaris* is characterized by a long distal prolongation of the virgula, and a very short virgella; *C. medius* has a long distal prolongation of the virgula, and also a long virgella; while in *C. rectangularis* the distal prolongation of the virgula is scarcely perceptible, and the virgella may be as much as 20 mm. in length.

4. *Climacograptus undulatus*, Kurck. (= *C. internexus*, Törnq. This species is characterized by its zigzag septal groove.)
5. *Diplograptus palmeus*, Barr.

6. *Diplograptus folium*, His.
7. *Diplograptus acuminatus*, Nich.
8. *Diplograptus cometa*, Gein.
9. *Diplograptus tamariscus*, Nich.
10. *Diplograptus bellulus*, Törnq.
11. *Diplograptus cyperoides*, sp. nov. (These two last species have no septum at all.)
12. *Diplograptus longissimus*, Kurck.

HETEROPRIONIDÆ.

13. *Dimorphograptus* cf. *Swanstoni*, Lapw.

This form differs from the true *Swanstoni* in having a longer sicula, and in the fact that the monoprionidian portion is curved and the diprionidian portion straight, while in Lapworth's species the whole rhabdosoma is curved. Törnquist suggests that if these features prove constant the name *Kurcki* should be given to the variety. G. L. E.

II.—CATALOGUE OF TERTIARY MOLLUSCA IN THE DEPARTMENT OF GEOLOGY, BRITISH MUSEUM (NATURAL HISTORY): PART I, THE AUSTRALASIAN TERTIARY MOLLUSCA. By GEORGE F. HARRIS, F.G.S. 8vo; pp. i–xxvi, 1–408, with eight plates. (London: Printed by order of the Trustees. Dulau & Co., 37, Soho Square, W. Price 10*s*.)

THE Catalogue of the Cephalopodous Mollusca, by Dr. A. H. Foord, commenced in 1888 (of which the third part, by Messrs. Foord & Crick, is just out), together with the Systematic List of British Oligocene and Eocene Mollusca, by Mr. R. Bullen Newton, in 1891, were the only volumes published on the Fossil Mollusca in the Geological Department until the present work appeared. Mr. George F. Harris has made an excellent commencement in Part I with the shells of Australasia, and we may hope in a few years to see a series of similar Catalogues by him of all the important groups of Fossil Mollusca issued by the Museum.

Great difficulty must always exist in dealing with the fossil mollusca by reason of the absence of the animal, the systematic worker being compelled in consequence to rely on shell-characters alone, and he must institute most careful comparisons with living forms, as well as with the contemporary fossil ones from other localities.

Mr. Harris has devoted much time to the study of both Recent and Tertiary Shells, and in conjunction with Mr. H. W. Burrows, he communicated a most valuable Memoir to the Geologists' Association (April 3, 1891) on "The Eocene and Oligocene Beds of the Paris Basin," which was printed and published as a separate part of their Proceedings on September 23 of the same year (pp. viii and 130), with a geological map and thirteen sections. He also published in 1891 an admirable Table giving an approximate correlation of the Tertiary Beds of Europe, accompanied by explanatory notes, as a supplement to Mr. R. B. Newton's List of Oligocene and Eocene Mollusca above referred to.

Before attacking the Tertiary Mollusca of Australasia Mr. Harris had the advantage of previously visiting and collecting from very many of the classic localities in France, Belgium, Germany, Italy, and Britain, as well as to a limited extent in Spain, Northern Africa, and the United States; also of studying many foreign museums, and of working over the French, Austrian, Italian, and British Collections in the National Museum, so that he has had excellent training for working out those from the Antipodes.

The present work embraces collections made by the late Hon. Walter Mantell, Sir James Hector, K.C.M.G., F.R.S., and others from New Zealand; by W. H. Grigson, Esq.; by John Dennant, Esq., F.G.S., and others from Victoria; the Count Strzelecki, and others from Tasmania; by Commodore Goodenough, R.N.; by Henry Y. Lyell Brown, Esq., F.G.S.; by R. Litton, Esq., and others from South Australia.

The most beautiful specimens described in this Catalogue are undoubtedly those obtained from the Murray River deposits, and from Muddy Creek, Victoria; amongst these may specially be mentioned the great *Cypræa* (*Erosaria*) *gigas*, the largest known species of *Cypræa*, living or fossil, presented by John Dennant, Esq., who is also the donor of many other Tertiary shells from Victoria, which now adorn the cases in the Molluscan Gallery VIII of the Geological Department. *Conus Newtoni*, sp. nov.; *Pleurotoma septemlirata*, sp. nov.; *P. subconcava*, sp. nov.; *Drillia oblongula*, sp. nov., and *D. vixumbilicata*, sp. nov.; *Voluta lirata*, Johnston; *Mitra multisulcata*, sp. nov.; *Latirus Tatei*, sp. nov.; *Murex Otwayensis*, sp. nov.; *Strombus denticostatus*, sp. nov.; *Tylospira coronata*, Tate (sp.); *Cerithium apheles*, Tenison-Woods; *Emarginula Wannonensis*, sp. nov.; *Liotia Roblini*, Johnston; *Turbo Hamiltonensis*, sp. nov., and *Turbo Etheridgei*, Tenison-Woods, are justly figured as new or interesting forms of shells from Australia.

A considerable space is taken up in the Plates in this work with drawings of the "protoconch" in *Tornatellæa*; *Adelactæon*; *Ringicula*; *Terebra*; *Conus*, *Leptoconus*, *Lithoconus*, *Chelyconus*; *Pleurotoma*; *Columbarium*; *Teleochilus*; *Daphnella*; *Harpa*; *Volutilithes*; *Lyria*; *Voluta*, *Pterospira*, *Aulica*, *Volutoconus*, *Amoria*; *Scaphella*; *Mitra*, *Cancilla*; *Uromitra*; *Conomitra*; *Fusus*; *Latirus*; *Leucozonia*; *Tritonofusus*; *Murex*; *Pseudovaricia*; *Euthria*; *Phos*; *Nassa*; *Lotorium*; and *Turritella*. Much reliance is placed by the author on this earliest (Embryonic) stage of shell-growth as a means of working out phylogeny. To the same end he also adopts four other stages: 2, Brephic; 3, Neanic; 4, Ephebic; 5, Gerontic;—or in common parlance: 1, Embryonic (generally passed in the egg); 2, Infancy; 3, Youth; 4, Adult; 5, Old Age, or senile stage.

Of course it is only in a few shells that we can distinguish any very strong contrasts, corresponding to these periods of life; but we can usually detect clearly, the Embryonic, the Ephebic, and the Gerontic stages; as to the Brephic and Neanic stages, they are not so easily defined in the Gasteropoda.

Curious and frequently eccentric as the Embryonic stage often appears to be in the Gasteropod, it is a question of some importance to ask whether the use of the *protoconch* can be relied upon as of general application for classificatory purposes in Fossil Malacology. Of course, in the study of extinct forms one is too often compelled to classify specimens upon imperfect materials, and in all such cases without having the soft parts of the animal to examine and compare; we must not, therefore, disparage the labours of the palæontologist, who honestly endeavours correctly to classify and name these testaceous remains and give us as truthful a report as possible of the molluscan fauna of the earth in past times.

We have said nothing concerning the fossil Lamellibranchiata from these Australasian deposits, but as they only occupy 93 pp. and number 54 genera, against 150 of Gasteropoda and Scaphopoda taking up 300 pp., this is not surprising. Nevertheless, at least one genus, occurring in the Australasian Tertiary beds, and also actually living on the Australian coast, the genus *Trigonia*, is of immense geological interest, being found fossil in all the Secondary rocks down to the Trias, and enjoying a worldwide distribution in the past.

We should like to suggest to the author that, as his work progresses, he should, if it be possible, try to map out these remnants of the Tertiary seas, and endeavour to give us an idea of the geographical distribution of the Mollusca of this past period so far as the collections at his disposal may serve to enable him to do so.

The work is carefully performed, and promises well for future volumes, which we hope will speedily follow.

III.—Catalogue of the Fossil Cephalopoda in the British Museum (Natural History): Part III, Containing the Bactritidæ and a part of the suborder Ammonoidea. By Arthur H. Foord, Ph.D. (Münch.), F.G.S., and George C. Crick, Assoc. R.S.M., F.G.S. 8vo; pp. xxxiv and 304 (with 145 illustrations in the text). (London: Printed by order of the Trustees, 1897. Dulau & Co., 37. Soho Square, W. Price 12*s.* 6*d.*)

THAT an interval of six years should have occurred since the issue of Part II of this Catalogue, suggests to the ordinary mind the slow movement characteristic of most geological agencies conducted on strictly Uniformitarian lines (not on cataclysmic action, as recently advocated in this Magazine by Sir Henry Howorth!). The delay in publication is mainly due to the transplanting of the original author of the work, Dr. A. H. Foord, from London to Dublin, a process which, although it has greatly retarded the issue of the present work, has, we trust, proved highly beneficial to him in more than one direction—as it happened to the patriarch long ago when he travelled to Padan-aran!

One important change which has resulted from Dr. Foord's removal from London, has been to throw a larger share of the work upon Mr. G. C. Crick; indeed, without his co-operation as joint author the volume could never have been completed. It is

satisfactory to learn that, with the exception of the delay in delivery, the Catalogue itself has not suffered loss, Mr. Crick remaining on the spot and carrying on the work after Dr. Foord's departure with loyal good-will; and now by their joint labours we have Volume III of this useful Catalogue delivered bound in its customary cloth covering.

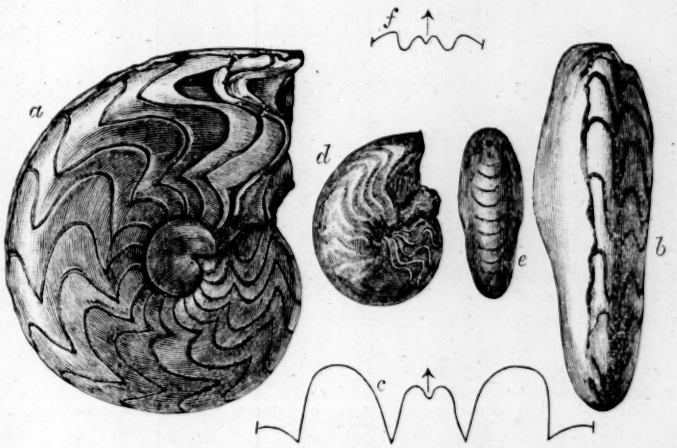


FIG. 1.—*a*, *Gephyroceras intumescens*, Beyr.; lateral view of a natural cast, from the Upper Devonian, Frasnes, Belgium; half nat. size. *b*, peripheral view of same specimen. *c*, suture-line of same. *d*, *Tornoceras simplex*, Von Buch; lateral view of a natural cast, from the Upper Devonian, Budesheim, Eifel; nat. size. *e*, peripheral view of same. *f*, suture-line of same species. (Fig. 25, p. 69, op. cit.)

Writing six years ago, Dr. Foord observed, in the Introduction to Part II, p. xvii, that in an earlier published Table of the Nautiloidea he had inserted the family Bactritidæ; but on reconsidering the question of the affinities of *Bactrites* (the sole representative of the family) in the light of the investigations of Branco and Hyatt, he was now prepared to accept the systematic position assigned to it by those authors—that is, at the commencement of the Ammonoidea. *Bactrites*, therefore, forms the subject of the opening chapter of Part III. Here under the genus *Bactrites* Dr. Foord gives us a summary of Hyatt's and Branco's investigations, and reproduces a series of interesting figures by Branco and others of the initial chambers of *Nautilus pompilius* (fig. 1, *a*, *b*, *c*, p. 41); of *Orthoceras elegans* (*d*); of *Cyrtoceras cornu* (*e*); of *Cosmoceras ornatum* (*f*, *g*, *h*); of *Belemnites Württembergicus* (*i*); of *Bactrites Hyattii*? (*k*); of *Bactrites gracilis* (*l* and *m*); of *Goniatites compressus* (*n*); and of *Spirula Peronii* (*o*).

After describing the initial chamber of *Bactrites*, of Nautiloids, Ammonites, Goniatites, Belemnites, and Spirulids, he points out that the shape of the initial chamber in *Bactrites* differs widely from that of the Nautilids, but agrees with that of *Goniatites compressus*.

These embryological studies of the shell bring out also most clearly the fact that in the earliest stages the great divisions of the Cephalopoda converge towards each other, and we arrive nearer to a common radical for the whole. Hence the difficulty which some authors have felt in deciding whether the genus *Bactrites* has stronger affinities with *Goniatites* or with *Orthoceras*.

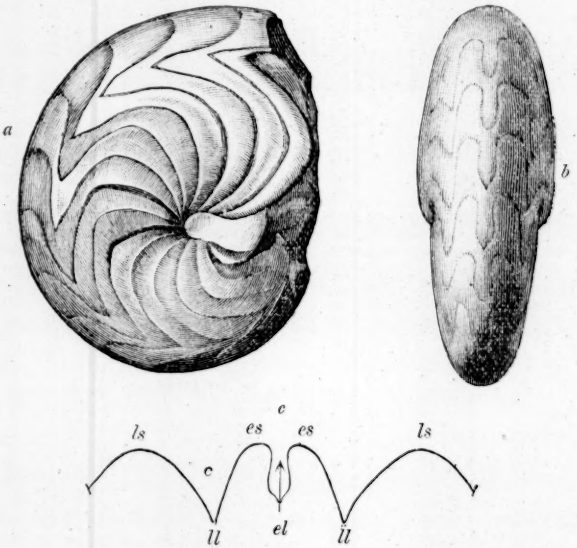


FIG. 2.—*Brancoceras Ixion*, J. Hall, sp. *a*, lateral view of a natural cast, from Goniatite Limestone, Kinderhook Group, Rockford, Indiana; *b*, peripheral view of same; *c*, suture-line; *el*, peripheral lobe; *es*, peripheral saddle; *ll*, lateral lobe; *ls*, lateral saddle. $\frac{3}{4}$ nat. size. (Fig. 62, p. 132, op. cit.)

The authors give us a clearly defined, yet comprehensive diagnosis for the suborder AMMONOIDEA, as follows:—"Shell conical, involute (most forms), or partly involute and partly evolute (*Scaphites*); sometimes bent on itself at one or both ends (*Ptychoceras*, *Diptychoceras*), or hook-like (*Hamites*), or even turreted (*Turrilites*), etc., or essentially straight (*Baculites*). Aperture simple, or with variously-formed lateral and ventral expansions. Suture-line undulating, serrated, or with more or less numerous digitate branches. Siphuncle marginal, without internal deposits. Initial chamber spherical or ovoid. Aptychus or anaptychus often present."

After discussing the merits of Dr. Paul Fischer's terms *Retrosiphonata* and *Prosiphonata*, the authors mention that Dr. E. Haug has pointed out that the Ammonites are retrosiphonate in the young, and that sometimes the prosiphonate stage is not attained (as in *Tirolites*) until the shell has reached a tolerably advanced age, a little before the last chamber. Instead of these terms, therefore, they rely on the important character of the sutures and divide the

Ammonoidea into two groups, viz. : Group A, to include the Clymenias and Goniatites with more or less simple sutures; Group B, to include the Ammonites with highly complex sutures.

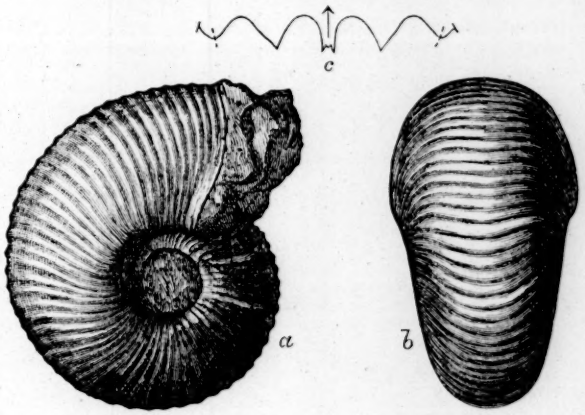


Fig. 3.—*Pericyclus Doohylensis*. *a*, lateral view; *b*, peripheral view; *c*, suture-line. (nat. size.) Carboniferous Limestone: Doohyle, near Rathkeale, co. Limerick, Ireland. (Fig. 72, p. 151, op. cit.)

The present volume is entirely occupied with Group A, Ammonoidea with more or less simple suture-lines, commencing with the family Clymenidæ, and the one genus *Clymenia* and eight species;

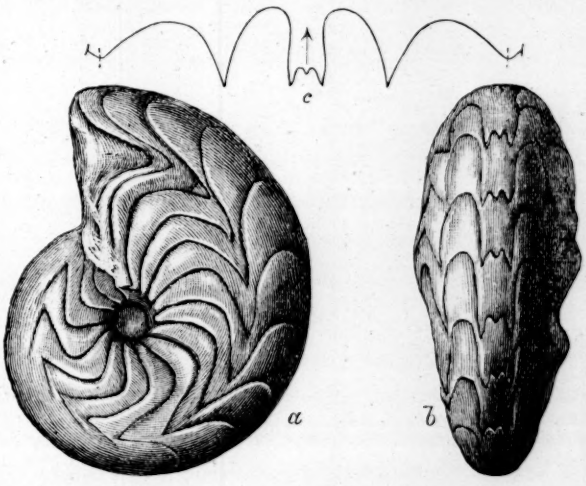


Fig. 4.—*Glyphioceras Hispanicum*, Foord and Crick. Carboniferous: Asturias, Spain. (nat. size.) *a*, lateral view; *b*, peripheral view; *c*, suture-line. (Fig. 91, p. 190, op. cit.)

the family Nautilinidæ containing the genera *Mimoceras*, *Anarcestes*, *Agoniatites*, and twenty-two species; the family Primordialidæ containing a single genus, *Gephyroceras*, with seventeen species; the family Magnosellaridæ, with the genera *Tornoceras*, *Mæneceras*, *Sporadoceras*, and twenty-six species; the family Glyphioceratidæ,

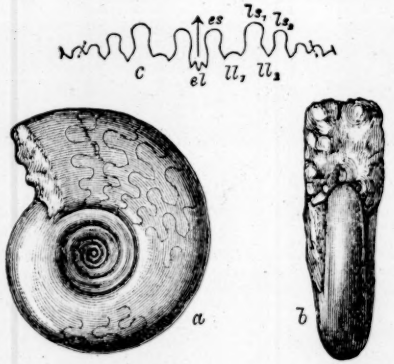


Fig. 5.—*Pronorites cyclolobus*, J. Phill., sp. *a*, lateral view; *b*, front view (nat. size); *c*, suture-line (letters to lobes and saddles as in Fig. 2; ll_2, second lateral lobe; ls_2, second lateral saddle). Carboniferous Limestone: Grassington, Yorkshire. (Fig. 125, p. 261, op. cit.)

with the genera *Brancoceras*, *Pericyclus*, *Glyphioceras*, *Nomismoceras*, *Dimorphoceras*, *Gastrioceras*, and fifty-eight species; the family Prolecanitidæ, with the genera *Sandbergeroceras*, *Prolecanites*, *Pronorites*, *Medlicottia*, *Agathiceras*, *Beloceras*, and seventeen species.

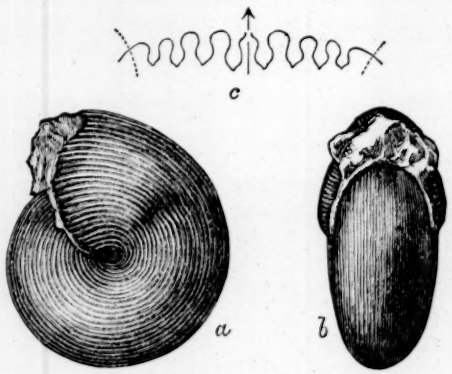


Fig. 6.—*Agathiceras Suessii*, Gemmellaro. *a*, lateral view, showing spiral ornamentation; *b*, front view, showing somewhat constricted aperture; *c*, suture-line. Permo-Carboniferous, Sicily. (Fig. 130, p. 269, op. cit.)

Group A is an interesting one, but in wealth of variation in form and in richness of suture-lines and ornament, Group B must necessarily far surpass it; nevertheless, we cannot fail to observe the gradual passage which takes place from the more simple forms

to the more ornate forms with more complex suture-lines, as is well shown in the Prolecanitidæ, by such genera as *Medlicottia*, *Sandbergeroceras*, *Gastrioceras*, etc.

The aptychi of *Goniatites* from the Upper Devonian, near Herborn, Nassau, are described and figured. There are, indeed, no fewer than 145 illustrations in the text, some of which are of very beautiful forms, as *Gastrioceras Jossæ* (fig. 109); *Glyphioceras Hispanicum* (fig. 91); *G. fimbriatum*; *Pericyclus Doohylensis*; *P. princeps* (fig. 68); *Prolecanites compressus* (fig. 116); *Agathiceras Suessii* (fig. 130).

The Introduction furnishes a useful summary of the Bibliography of the Goniatites and their allies, of which Group A is chiefly composed.

The Triassic Ammonites, on which Mojsisovics has laboured so long and so successfully, will probably fill Part IV; this we hope will shortly follow the present volume. Beyond these lie the Ammonites of the Jurassic and Cretaceous formations, and the hosts of the Belemnites, the Squids, and Cuttles! We can only congratulate the authors and wish them "more power"; we may even venture to suggest that they may find it needful to take more hands aboard and hoist more sail, or the "Argonaut" will never reach her port.

REPORTS AND PROCEEDINGS.

Geological Society of London.

I.—May 12, 1897.—Dr. Henry Hicks, F.R.S., President, in the Chair. The following communications were read:—

1. "On the Gravels and associated Deposits at Newbury (Berks)." By E. Percy Richards, Esq., F.G.S.

After a general sketch of the geology of the Valley of the Kennet, the superficial deposits at and in the neighbourhood of Newbury are described in detail, from observations made by the author during the progress of the main drainage works in 1894.

The author classifies the strata which he has examined in five groups—

(1) The Preglacial Southern Drift.
(2) The Glacial Drift (Donnington).
(3) The Upper River-gravel.
(4) The Lower River-gravel.
(5) The Neolithic peat-beds (shell-marl, peat, and loam).

(1) The first of this series is the flint-gravel constituting the heathy Commons north and south of Newbury (as of Snelsmore and Greenham). About 6 feet of gravel is exposed at the average level of 440 feet above Ordnance datum. It was referred to the "Southern Drift" by the late Sir Joseph Prestwich. At the edges of the Commons some of this gravel slips down and mixes with glacial deposits of later age.

(2) North of the town are the Glacial Gravel and Loam of Donnington and the Bath Road (17 feet), ranging from 254 to 300 feet above O.D. At the confluence of the Lamborne and Kennet Valleys these beds have been much denuded. The thickness, character, and composition of these deposits, as well as those of other gravels, etc., described hereafter, have been carefully noted by the author.

(3) The River-gravels of the Kennet Valley are of great interest, and have been carefully studied by the author at their several exposures, in Bull's Lane, the Enbourne Road, etc. Here the Upper River-gravel forms fine broad terraces at about 260 feet O.D. Palæolithic flint implements are not uncommon in this gravel. Bones and teeth of mammoth, common and extinct ox, sheep, pig, horse, and reindeer have also been found in it. Immediately north of Newbury this terrace is cut off locally from the town by an east-and-west fault at Northcroft, but is distinct a little farther to the west.

(4) The Lower River-gravel lies in the middle of the valley under the peat-beds of Newbury, and rests on the Chalk. It appears to have been derived from all the other gravels, but with a large percentage of flints direct from the Chalk. It is about 10 feet thick locally, and at some places has a white clay at its base.

The author finds that this gravel forms ridges across the valley, which seem to have been the limits of shallow-water areas, in which peat-bogs and clear pools with river-shells were locally produced (5), giving rise to patches and alternations of peat and marl. These varied in extent and in thickness, according to the damming-up of the lakes and their being drained by the currents causing gaps in the gravel-barriers, which are more or less easily traced. The peat varies from mere seams to beds 5 or 6 feet in thickness, and the marl from a few inches to 8 feet. The shells and bones found in the peat and shell-marl are enumerated, much as in earlier lists; so also are the plant-remains.

Above the peat-beds in the town of Newbury about 4 feet of coarse triturated gravels represent layers of road-material laid down in Roman and mediæval times; these are blackened with ancient sewage, and contain various metal and other relics. Cannon-balls fired from Donnington in 1644 A.D. occurred only 18 inches below the road-surface; "macadam" has been accumulated on the top to a thickness of $2\frac{1}{3}$ feet. A pile-structure of fir-wood was discovered in the peat in St. Bartholomew Street.

[Full references to published memoirs on the subjects of this paper and some additional Notes are given in an Appendix; and Notes on the Mollusca are contributed by Messrs. A. S. Kennard and B. B. Woodward.]

3. "The Mollusca of the Chalk Rock: Part II." By Henry Woods, Esq., M.A., F.G.S.

The first part of this paper, dealing with the Cephalopoda, Gasteropoda, and Scaphopoda, appeared in the last volume of the Quarterly Journal (vol. liii, p. 68). In the present communication the author gives an account of the characters, synonymy, and

distribution of the Lamellibranchia: 29 species are recognized, six being new. The genera represented are: *Leda*, *Nucula*, *Arca*, *Limopsis*, *Modiola*, *Inoceramus*, *Ostrea*, *Chlamys*, *Lima*, *Spondylus*, *Plicatula*, *Cardium*, *Cardita*, *Arctica*, *Trapezium*, *Corbis* ?, *Martesia* ?, and *Cuspidaria*.

In the concluding part the author compares the fauna of the *Reussianum*-zone (Chalk Rock) in England with that of other European areas, particularly N.W. Germany and Saxony. In the latter country the number of species in some groups—especially Gasteropoda and Lamellibranchia—is much greater than in England; this difference is probably due to the sea having been of less depth than in the English area. It is noticed that the species of Cephalopoda have a much wider geographical range than the other groups of the Mollusca.

Finally, by a study of the present distribution of those genera—which form the predominating element in the fauna—taken in conjunction with the other characters of the zone, the author arrives at the conclusion that in England the *Reussianum*-zone was probably formed between the depths of 100 and 500 fathoms.

CORRESPONDENCE.

ACANTHONAUTILUS BISPINOSUS.

Sir,—Mr. Foord will find the first cousin, if not the brother, of his *Acanthonautilus bispinosus*[1] figured in "Matériaux pour la Palæontologie Russe," Tom. i, 1869, in Tab. v of a paper by Golowkinsky on the Permian formation of the central part of the Kama-Volga basin. It is there called *Nautilus cornutus*.

J. F. Blake.

Geological Society, Burlington House, W.
April 12, 1897.

ACANTHONAUTILUS: A CORRECTION.

Sir,—In the April number of the Geological Magazine appears a description of *Acanthonautilus* as a new genus. As this has already been published in Dr. Foord's Inaugural Dissertation (München, in 1896), "Ueber die Orthoceren des Kohlenkalks [Carboniferous Limestone] von Irland, etc.," the statement that it is new is likely to mislead the student.

C. Davies Sherborn.

540, King's Road, London, S.W.
April 26, 1897.

Sir,—Since my paper on *Acanthonautilus bispinosus* appeared in your April number, my attention has been directed to a work in the Russian language ("Material for the Geology of Russia," vol. i, 1869), containing a paper by N. Golovkinsky, in which is figured and described a species—*Nautilus cornutus*—closely related to mine, though from a higher horizon, the Permian. From a study of the figures it is clear that the species are quite distinct. Thus, in *A. bispinosus* the shell expands rapidly, and has a broad and shallow

[1] Geol. Mag., April, 1897, p. 147, Pl. VI.

hyponomic sinus; the spines (similar in structure in the two species) are nearly straight, and slightly inclined downwards. The septa are not numerous. In the Russian species, on the other hand, the shell is more slowly expanding, the hyponomic sinus small and inconspicuous, the spines slightly curved, and inclined upwards. The septa, only faintly indicated on the larger of the two specimens figured, are more numerous than in the Irish species. The siphuncle, not seen in *A. bispinosus*, is in *N. cornutus* subcentral, and inclined towards the inner margin of the shell; this is the case at least in the smaller of the specimens figured, which also shows in a section the slow expansion of the whorls.

The discovery of the Irish Carboniferous species shows that this peculiar type of Nautiloid had a wide geographical range, while its appearance in the Permian of Russia extends its range in time.

The work in which *N. cornutus* is described seems to have been generally overlooked, as I have seen no reference to it even in books and papers dealing exclusively with Carboniferous or Permo-Carboniferous fossils.

My thanks are due to you, Sir, for your courtesy in allowing me to see Professor Blake's letter, thus enabling me to compare and comment upon the two species; and to Professor Blake science is indebted for having drawn attention to this "first cousin" of *A. bispinosus*.

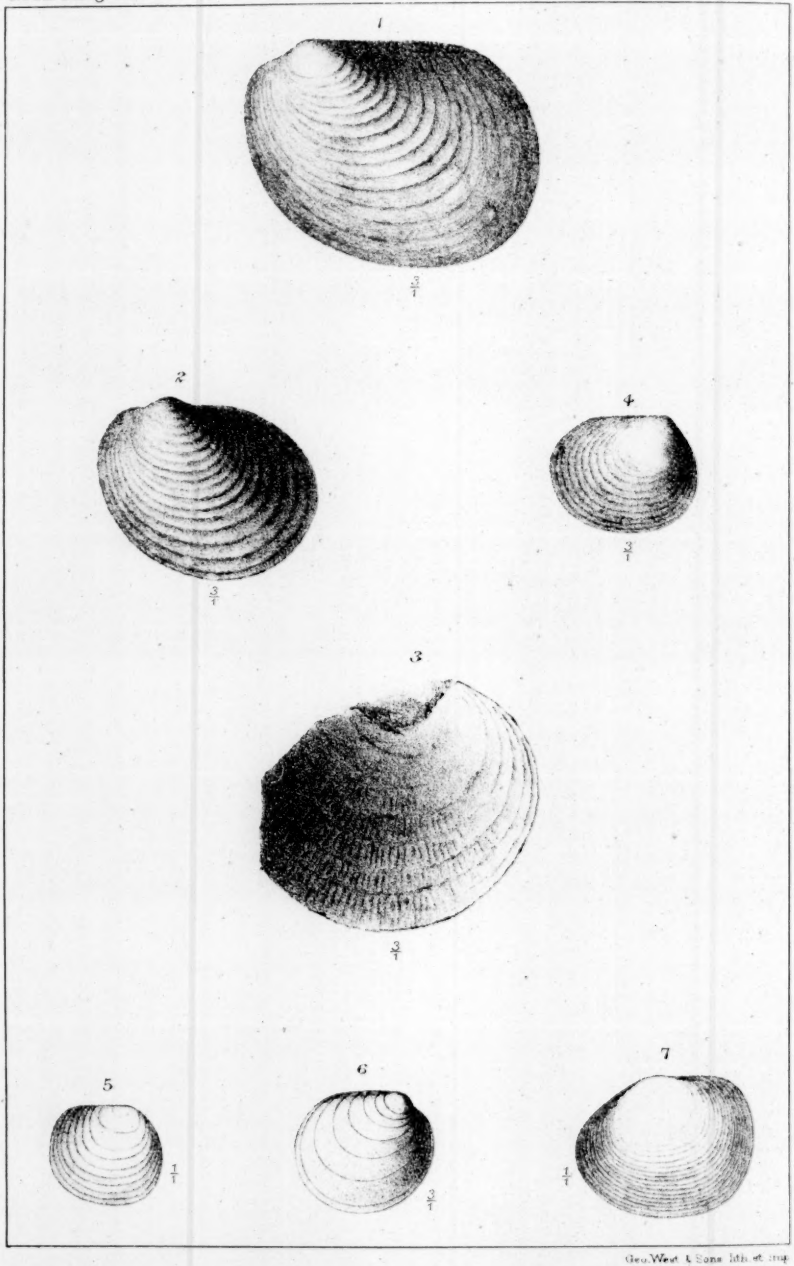
ARTHUR H. FOORD.

DUBLIN, *May* 13, 1897.

P.S.—With reference to Mr. Sherborn's letter which you have also kindly granted me the privilege of perusing, I can only say that I did not consider that the private distribution of a few copies of a paper could fairly constitute publication. The fact, however, seems to be that when once a paper has left its author's hands, and can therefore be quoted, it must be considered as published. I am obliged to Mr. Sherborn for pointing this out to me; I could have no better authority to guide me in the matter than his.—A. H. F.

MISCELLANEOUS.

"THE Distribution of Drift in Ireland in its relation to Agriculture" is the title of a paper by Mr. J. R. Kilroe (Proc. Royal Dublin Soc., ser. 2, vol. viii, 1897, pp. 421–431: published separately, price 6*d*.). It is accompanied by a geological map, printed in colours to show the areas where the more solid rocks appear at the surface, the large tracts (two-thirds or more of the country) which are covered by various drift deposits being left blank. As the author rightly points out, a map that would meet the requirements of the agriculturist must show, on a fairly large scale, the distribution of the subsoils, and indicate not only the materials of which they are composed, but their thicknesses at different localities, and in some cases the subjacent strata. This could be indicated by colours, letters, and numbers; and the author's aim is to make suggestions towards this object. He appends a table showing the nature of soils, subsoils, and boulder-clays in various parts of Ireland.



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